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VEGETATION OF THE LAKE TAHOE REGION

A Guide for Planning

Prepared for

Tahoe Regional Planning Agency

and

Forest Service, U. S. Department of Agriculture

South Lake Tahoe, California

June 1971

ACKNOWLEDGMENTS

Establishment of the Tahoe Regional Planning Agency was consented to by the Congress through enactment of Public Law 91-148. On March 19, 1970, the governors of Nevada and California signed the proclamation that proclaimed creation of the Tahoe Regional Planning Agency. Since the authorized staff of the Agency was small, it enlisted help from several committees composed of technical specialists and other citizens concerned with resource conservation and orderly development of the Tahoe environmental resources.

The planning effort has been aided greatly by generous cooperation from numerous federal, state, county, and municipal agencies and from several colleges and interested private individuals. Cooperating agencies included:

Federal:

Department of Agriculture: Forest Service; Soil Conservation Service

Department of Commerce: Environmental Science Services Administration

Department of Defense: Army Corps of Engineers

Department of Interior: The Bureaus of Mines, Outdoor Recreation, Reclamation, Sport Fisheries and Wildlife; Federal Water Quality Administration; and the Geological Survey

Department of Transportation: Coast Guard; Federal Highway Administration; Federal Aviation Administration

State:

California: The Resources Agency of California

Nevada: The Nevada Department of Conservation and Natural Resources

County and Municipal:

Carson City, Douglas, and Washoe Counties, Nevada; El Dorado and Placer Counties and City of South Lake Tahoe, California

Schools:

Foresta Institute; Sacramento State College; Tahoe College; University of California at Berkeley and Davis; University of Nevada; Desert Research Institute

Any publication that compiles and presents information from so large and disparate a group of contributors as this one does is susceptible to error, inconsistency, and omission. Sustained effort has been made to avoid these flaws; but if it has failed occasionally, the reader's forbearance is humbly solicited.

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COMMITTEE MEMBERSHIP

This report on the vegetation of the Lake Tahoe Region was prepared by a committee of specialists appointed by the Tahoe Regional Planning Agency and the Forest Service Planning Team. Their purpose was to describe and discuss the role of plant life in the continuing process of evolution seen in this area. The committee acknowledges generous cooperation from many of the agencies listed on the preceding page. Membership of the Vegetation Committee is:

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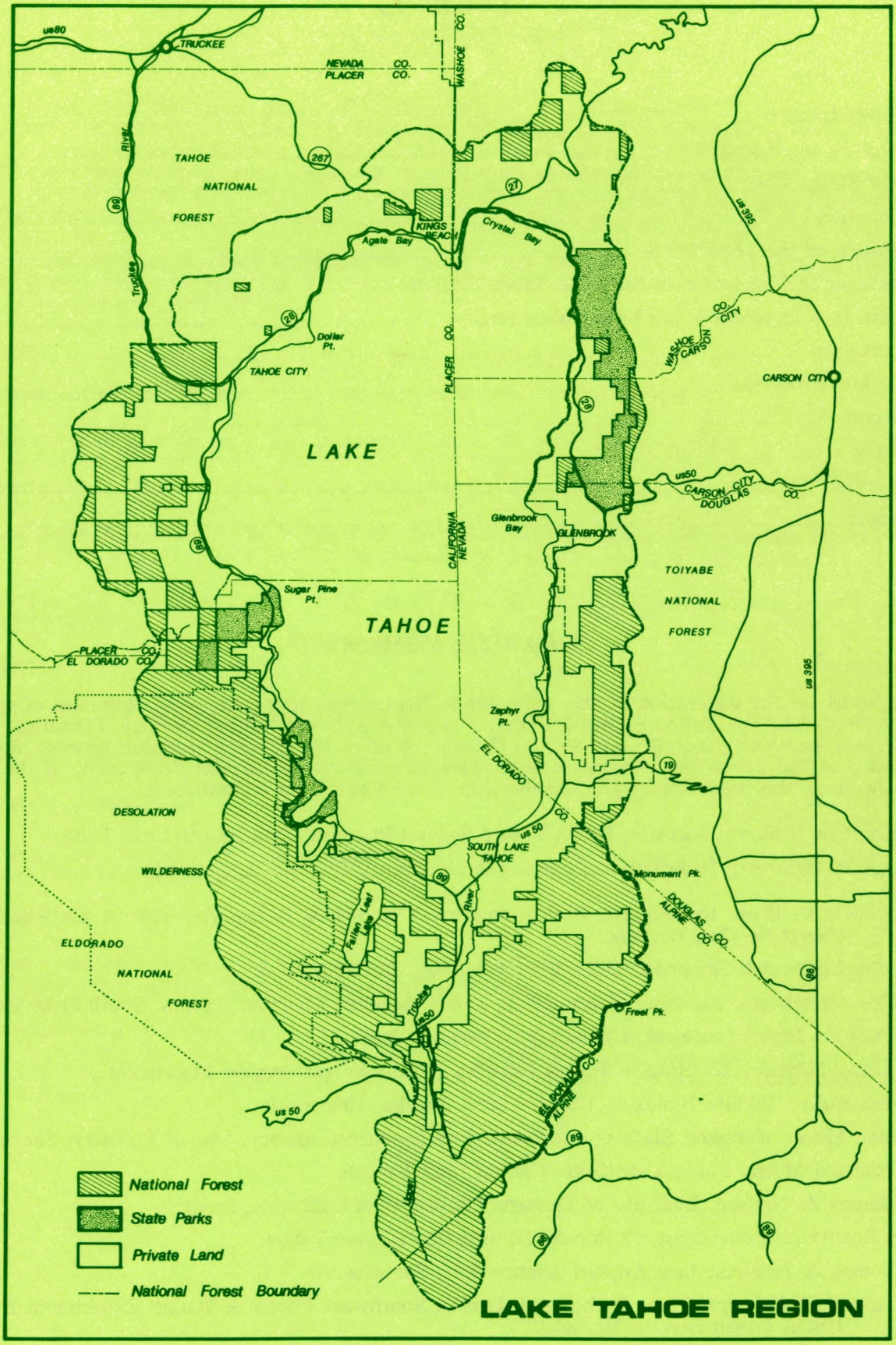

us80
TRUCKEE
NEVADA CO.
PLACER CO.
WASHOE CO.
TAHOE
NATIONAL
FOREST
267
89
21
KINGS BEACH
Agate Bay
Crystal Bay
us 395
Truckee River
28
Dollar Pt.
TAHOE CITY
PLACER CO.
WASHOE CO.
CARSON CITY
CARSON CITY
LAKE
us50
CARSON CITY
DOUGLAS CO.
Glenbrook Bay
GLENBROOK
CALIFORNIA
NEVADA
TOIYABE
NATIONAL
FOREST
Sugar Pine Pt.
TAHOE
PLACER CO.
EL DORADO CO.
us 395
Zephyr Pt.
EL DORADO CO.
19
DESOLATION
WILDERNESS
us 50
SOUTH LAKE TAHOE
Monument Pk.
DOUGLAS CO.
ALPINE CO.
Fallen Leaf Lake
Taylor River
ELDORADO
NATIONAL
FOREST
Freel Pk.
us 50
EL DORADO CO.
ALPINE CO.
National Forest
State Parks
Private Land
National Forest Boundary
LAKE TAHOE REGION

INTRODUCTION

The casual **visitor** to Lake Tahoe presumes the vegetation to be an indestructible part of the landscape. The **preservationist** believes that the beauty of the vegetation is not receiving the attention it deserves. The **conservationist** is convinced that man exerts a continuing and ever increasing impact on vegetation and the rest of the environment, but that he is not adequately using his intelligence to retain environmental balance. To many others, unfortunately, protecting the natural vegetation in preparation for some new land use is simply a cost that outweighs the benefits.

General features of the Lake Tahoe Planning Area

Lake Tahoe and the mountainous timber-covered basin immediately surrounding it provide one of the most beautiful environments in the Sierra Nevada and in the nation. The Lake itself, an irregular oval about 22 miles long by 12 miles wide, covers 191 square miles; it occupies a deep depression between crests of the Sierra Nevada and Carson ranges. Since its surface is 6,225 feet above mean sea level, Lake Tahoe is one of the largest high-altitute lakes in the world. The clarity and purity of its water are outstanding. In fact, protection of quality of the water in Lake Tahoe is a primary objective for effective control of the region's environment.

The spectacular scenery of the Lake Tahoe Region results from unique geological conditions that prevailed when the lake was formed. The basement rock is predominantly granite related to the rocks found throughout the Sierra Nevada. On the other hand, the geologic structure—the faulting that produced the lake basin itself—is related to the Basin Ranges that extend eastward from the Sierra to the Wasatch Range in Utah. The lake was formed by a natural dam—a great pile of andesitic mudflow breccia—across the north outlet.

Lake Tahoe is on the eastern boundary of that part of the Sierra Nevada that was extensively glaciated during the Pleistocene epoch. Huge valley glaciers moved down canyons along the western side of the lake, scouring away loose rock and building up great piles of morainal debris. Along the eastern side, glaciers developed only on the shaded side of the highest peaks; so most of this area was not glaciated. This accounts for the subdued rolling topography typical of the Carson Range, as contrasted to the rugged Sierran crest on the west side of the basin.

Climate of the region is strongly influenced by topography. Marine air from the Pacific Ocean, 150 miles to the west, drops its moisture (mostly as snow) as it rises over the crest of the Sierra. Average annual precipitation ranges from more than 50 inches on the western side of the region to about 25 inches along much of the eastern shoreline. The Weather Bureau at Tahoe City, on the west side, reports long-term average snowfall of 213 inches. The fairly long summers are comparatively cool; mean maximum temperature at Tahoe City in July over a 50-year period was 78°F. Winters are cold but seldom severe; mean daily minimum temperature for January over the same period was 17°F. The high elevation and cool temperatures result in a short growing season—an average of only 70 to 120 frost-free days per year at various points near the Lake.

Vegetation includes desert, montane, and alpine species typical of the eastern slopes of the Sierra. Pine and fir forests were heavily logged between 1860 and 1900 when demand for lumber and props for the Nevada silver mines was high. Even so, today the region has good stands of conifers between the Lake level and 9,000 feet, plus considerable areas covered by chaparral and other brush. On fairly level open areas that have a few inches of soil, grasses and other herbage flourish during the short growing season.

Numerous species of wildlife inhabit the Lake Tahoe Region. Deer, bear, mountain lion, coyote, rabbit, raccoon, and several rodents are common. Land birds and waterfowl are present in small numbers consistent with available habitat. Heavy commercial fishing in the Lake around 1900 depleted native populations of cutthroat trout and whitefish, but kokanee salmon and several species of fish stocked from state hatcheries provide good recreational fishing today. Numerous tributary streams also provide sport fishing.

Soils are generally shallow and highly erodible—easily disturbed and slow to stabilize—but the soil is fairly deep in some bottom lands and glacial debris areas. The varied climate and highly erodible soils combine to make the Lake Tahoe region a fragile environment. Hence the ecological balance

is easily upset. Whenever vegetation is removed, it is not soon replaced. Erosion by wind and water is a constant hazard; it damages pristine features of the Lake, including the spawning areas of native fish.

Changing Environment

Before the white man invaded this area about the middle of the 1800's, the somewhat nomadic Washo Indian tribe inhabited it. Their name for the lake, "Tahoe," has been variously translated as "big water," "high water," or "water in a high place." The first recorded white visitors were John Fremont's exploring party (1844); they were soon followed by the Forty-niners and other western migrants and adventurers.

During most of the following 100 years, Lake Tahoe was the summer recreation area for wealthy Californians, mostly from San Francisco and the Sacramento Valley. The few summer resorts, scattered stores, service stations, and restaurants hardly marred the natural beauty of the region.

Soon after World War II all this began to change. With increased general affluence, steadily and rapidly increasing numbers of vacationers began to visit the area; their visits gradually extended the "season" from summer to the full year. Establishment of year-round casinos at Stateline in 1955 and the phenomenal growth of winter sports added to the influx of both visitors and residents. By unofficial count in 1965, the region had nearly 29,000 yearlong residents—more than double the 1960 federal census figure. Present projections anticipate more than 50,000 residents by 1980 and an added summer population topping 250,000.

These projected increases in resident and transient populations will inevitably multiply and intensify the environmental problems that already are plaguing the area. Hence the crucial need for planning orderly development that can be sustained by the natural capacities of the region.

Administrative and Governmental Responsibility

The Planning Area established by the Bi-State Planning Compact between the States of California and Nevada is a basin covering 327,878 acres plus 3,340 acres near the Lake outlet in the Lower Truckee River drainage. This includes the 122,628 acres of lake surface. Governmental jurisdiction over land in the Lake Tahoe Planning Area is complex. The Area is divided between California (Placer, El Dorado, and Alpine counties) and Nevada (Washoe and Douglas counties and Carson City). This division of governmental responsibility makes it difficult to coordinate the administration of government in the Area in the interest of protecting the environment.

Nearly half (48.7 percent) of the land area is federally-owned—chiefly in three National Forests totaling 103,872 acres. An additional 4.5 percent is state owned, nearly all in State Parks. Thus about 53 percent of the land in the Planning Area is publicly owned.

Of nearly 75 miles of lake shoreline, about 18 percent is publicly owned. This is chiefly 8 miles belonging to the State of California and 5.5 miles in National Forests.

Tahoe Regional Planning Agency (TRPA)

The Tahoe Regional Planning Agency began work as soon as the governors of California and Nevada signed the proclamation creating the Bi-State Planning Agency. Public Law 91-148 had enumerated the dangers of deterioration of the natural environment at Tahoe and of the increasing demands on various natural resources and features of the Region; also, it emphatically stated the need to maintain equilibrium between the Region's natural endowment and limitations on one hand and the environment that man is creating. It recognized need for establishing "an area-wide planning agency with powers to adopt and enforce a regional plan of resource conservation and orderly development, to exercise effective environmental controls, and to perform other essential functions. . . ."

TRPA was ordered to develop and adopt, within 18 months of its formation (i.e., by September 1971), a plan for regional development that would include separate plans for land use, transportation, conservation, recreational development, and public services and facilities, to name a few. The Agency was further directed to consider and to seek to harmonize the needs of the whole Region

with the plans of local governmental units and the existing land use plans of State and Federal agencies.

Since nearly half of the land area in the Lake Tahoe Region is in National Forests, the Forest Service has major responsibility for improving environmental features here. In 1970 it established the Lake Tahoe Basin Planning Team to work with TRPA. Although the Agency and Team have separate organizations and responsibilities, they have cooperated closely to achieve a common goal.

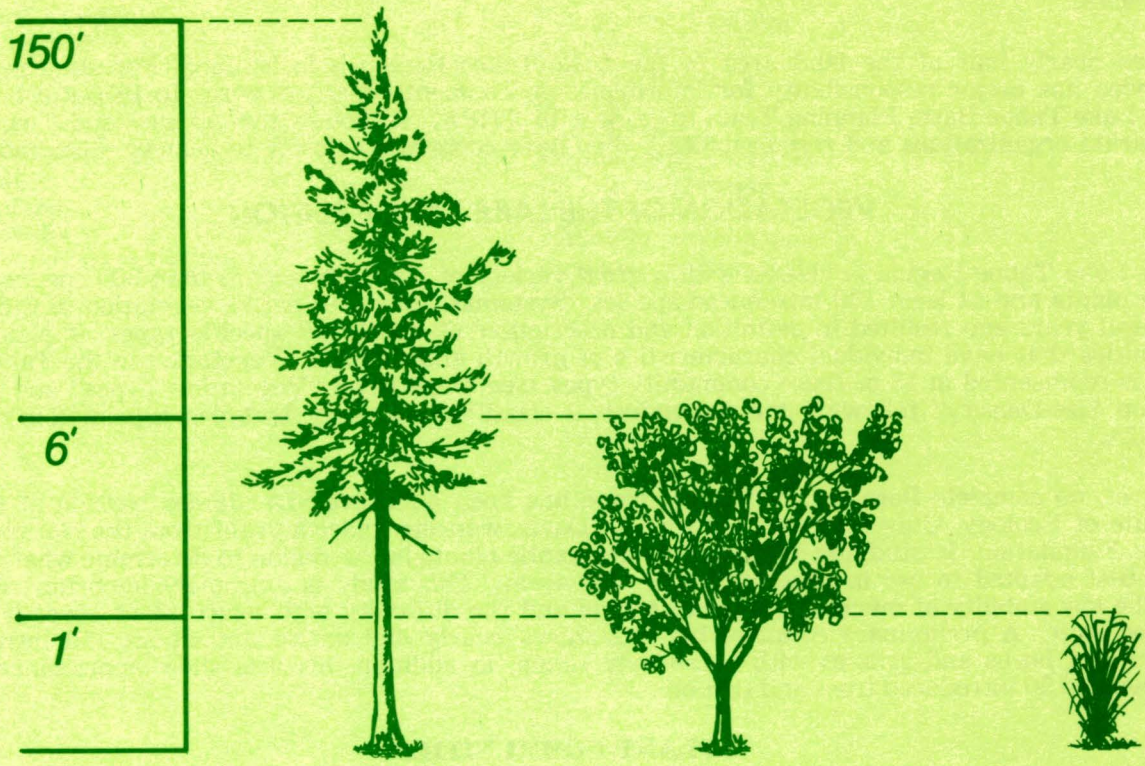
VEGETATION OF THE LAKE TAHOE REGION

The Lake Tahoe Region is blessed with a great variety of plant life—more than 500 species of native plants and at least 160 introduced species. Systematic study of native vegetation in California several years ago resulted in definition and description of nearly 30 specific types of plant communities that have individual characteristics of growth and survival. Vegetation in the Tahoe region is represented in 13 of these community types (see maps titled "Vegetation Types" and "Vegetation Size-Density" following the Appendix); a classified inventory, by types, is printed in the Appendix.

As yet, no complete flora for the Tahoe region has been published. Dr. James Neilson of the Institute of Ecology, University of California at Davis, working under a grant from the National Science Foundation, is studying both native and exotic plants in the region to determine what species are best adapted to use in revegetating eroded areas. This study is extremely important in view of the low stability of much of the area's topsoil and the difficulty with which plant cover is established in it. A preliminary count of his lists shows nearly 450 native and about 110 introduced species of herbs and grasses with non-woody stems; in addition, his lists show approximately 65 native and 50 introduced trees and shrubs.

PLANT COMMUNITIES

Plant communities can be divided into horizontal segments according to the type and height of the plants growing in them. These associations are the result of a combination of natural and man-caused forces to which any area is subject. Most plant communities contain three elevational layers of vegetation, which for convenience may be called the overstory, the eye-level layer, and ground cover (see sketch). The overstory is mostly trees but includes shrubs and vines with woody stems. In the Tahoe region the overstory is dominated by pine, fir, cedar, and aspen. The eye-level layer (1 to 6 feet in height) contains woody-stemmed plants, forbs, shrubs, vines, and small trees. The ground cover (from ground surface to 1 foot height) is almost entirely herbaceous vegetation, i.e., grasses and other non-woody plants, but includes very young trees.



General knowledge of these plant communities, their occurrence, and the native species in each layer can help a land use planner in several ways; for example, (1) in selecting plants for use in stabilizing soil; (2) in designating others as sources for building materials or for home decoration and landscaping; and (3) in identifying species that provide food for the wildlife population. Detailed knowledge of these species will also help him relate these different communities and individual species to such uses as filtering noise, absorbing air pollutants, screening, and reduction of wind velocities.

LIFE SPANS AND MAINTENANCE OF THE VEGETATION ECOSYSTEM

Often when landscape and architectural plans call for retention of certain trees, shrubs, or grasses, little thought has been given to their life spans and life expectancy. Landscape plans and architectural renderings may often reflect aesthetic foresight by retaining certain trees, shrubs, or grasses, but simultaneously display inadequate forethought for the varied life expectancies of the plant species they have used.

Each plant community is an aggregation of species, many of which have different life spans. Thus, the age structure and growing trends of any given plant community are constantly changing. It is important to consider these changes when planning the vegetation for shade, screen, sound barriers, and soil management.

Annual grasses and many perennial herbs are comparatively short lived (one to several growing seasons); some woody-stemmed shrubs persist for 75 to 100 years; and the coniferous trees in a mature forest may have 350 years of continuous growth. In the alpine type (type 20), several junipers have attained ages of 600 years.

The majority of the woody-stem types now in their second and third growth cycles average 75 years of age and contain many elements of youthful stands. This is very important because a well working **nutrient cycle** capable of utilizing most of the nutrients on a site takes at least a century to develop. Similarly, soils that depend on the vegetation and climate (major components of an ecosystem) require two to three centuries to develop.

Repeated interruption of cycles of plant growth and their various ecological integrals causes loss of nutrient, erosion, scenic impairment, and possibly soil exhaustion. To circumvent such kinds of environmental deterioration, it is necessary to give careful attention to building design and jurisdictional planning that will create zoning adapted to vegetative types and correlated to local soil, climate, and topography. If such measures are implemented in the near future, the forest ecosystems may have ample time to reestablish themselves effectively.

Growing seasons

The geographic distribution of plants is generally governed by their range of tolerance to grow under varied combinations of climate, soil, moisture, and topography.

The correlation of plant communities along the north-south axis of the Tahoe Region is significant, but considerable differences appear across the Region in a west-to-east gradient. The north-south axis coincides with that of the Sierra-Nevada on the west and the Carson range on the east, but is modified somewhat by the presence of Mount Rose at the northeastern end. The west-east gradient coincides with the precipitation patterns which follow a similar west-to-east gradient and is modified only by differences in altitude that relate, in turn, directly to effects of temperature, wind-evapotranspiration, and soil moisture. Given an abundance of water, temperature is the principal factor for establishing the growth period; hence, the growing period is related to the number of hours above a minimum temperature (usually 40°F.) that permits a plant to grow and can be stated as the "degree days" necessary for the growth cycle.

Within any plant community the range of growing periods among the species is usually limited, and the total range can be thought of as the growing season of that community. The growing period is often modified (particularly here in the western U. S.) by limitation of available moisture. The normal winter-wet and summer-dry climate in the Tahoe Region is modified slightly by summer thundershowers.

Soil moisture

Plants generally distribute themselves according to their ability to grow under various ranges of moisture. They are limited principally by their ability to establish themselves and survive under the maximum or minimum extremes of available water.

Soil acts as a reservoir of moisture, but in this Region the supply may be limited by shallow soils, small surface area of soil particles, and the rapid underground drainage. Plants can draw on the deep groundwater supply up to a point.

As air temperatures rise, water vapor moves from leaves (evapotranspiration). To replace moisture lost by transpiration, plants draw on soil water as long as it is available. As this source becomes limited, plants must adjust in order to survive.

In the following diagrams of seasonal evapotranspiration, seasonal temperatures (expressed as a function of water evaporation) are related to annual precipitation, the plant's ability to control water loss in its leaves, and its ability to extract moisture from the soil.

The critical period for plant growth is shown in that portion of the curve when average daily temperatures are sufficiently above the minimum to permit plant growth and the length of time water is available during the season. The period between the depletion of soil water and substantial autumn rain is a period of survival which the plant meets in a variety of ways; restricted transpiration of water (trees and shrubs), withdrawal into seeds (grasses), or dormancy (forbs). By the time substantial autumn rains begin, temperatures are low enough that the plants are hardly growing and are preparing for winter dormancy.

Tahoe City (fig. 1) receives approximately 10 inches more annual rainfall than Glenbrook (fig. 2) across the Lake to the east. The evapotranspiration curve indicates the average plant community growing periods at Glenbrook and is contrasted with that at Meyers (fig. 3) at the south end, where rainfall is approximately the same as at Tahoe City. The influence of altitude is illustrated by the diagram for the Snow Laboratory near Norden on the crest of the Sierra (fig. 4).

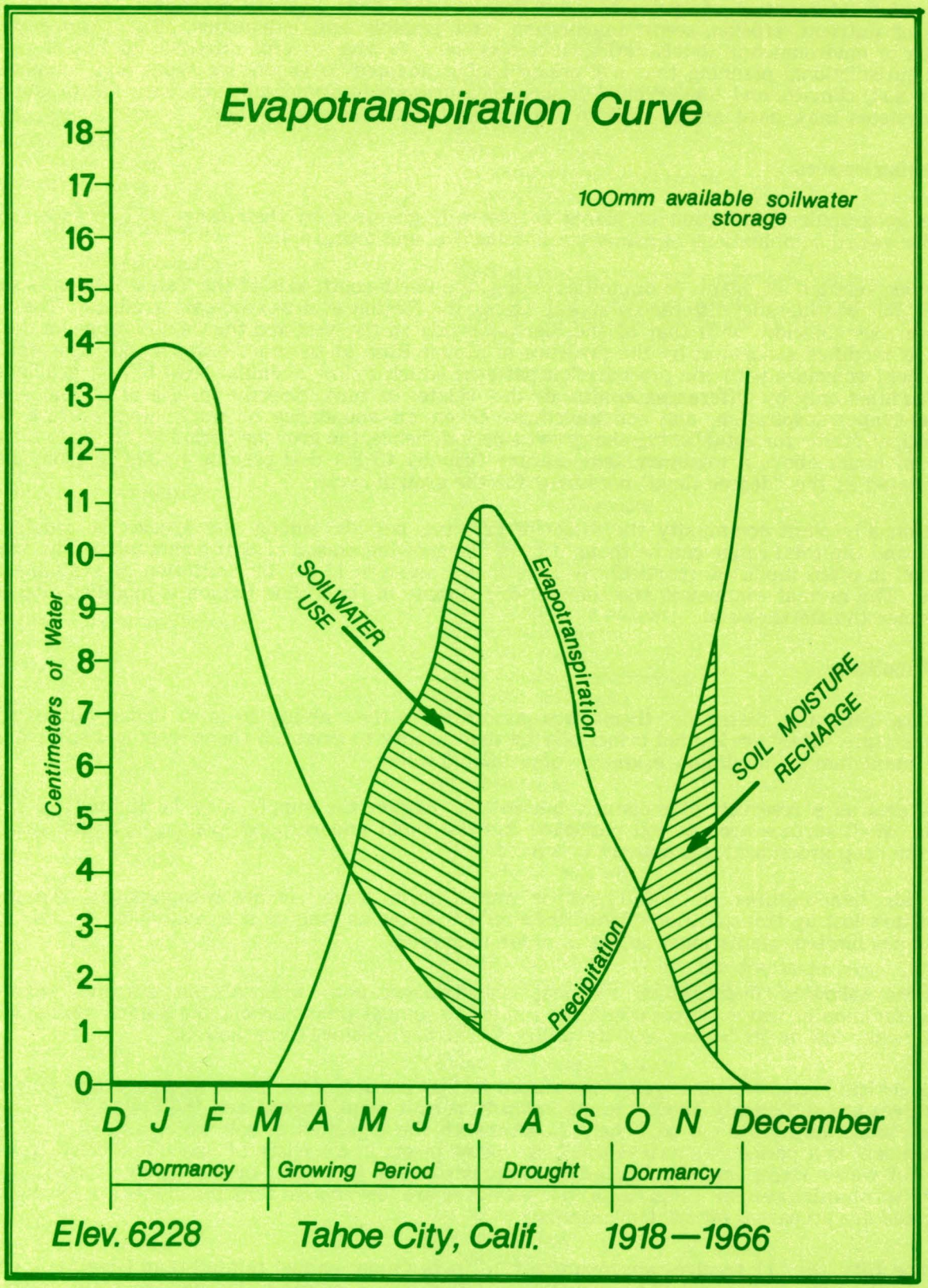


Fig. 1 - Evapotranspiration diagram derived from the 54 years of continuous records of temperature and precipitation at Tahoe City weather station. Data courtesy of Dr. Jack Major, Dept. of Botany, U.C., Davis. Associated vegetation types are montane chaparral and mixed-conifer forest.

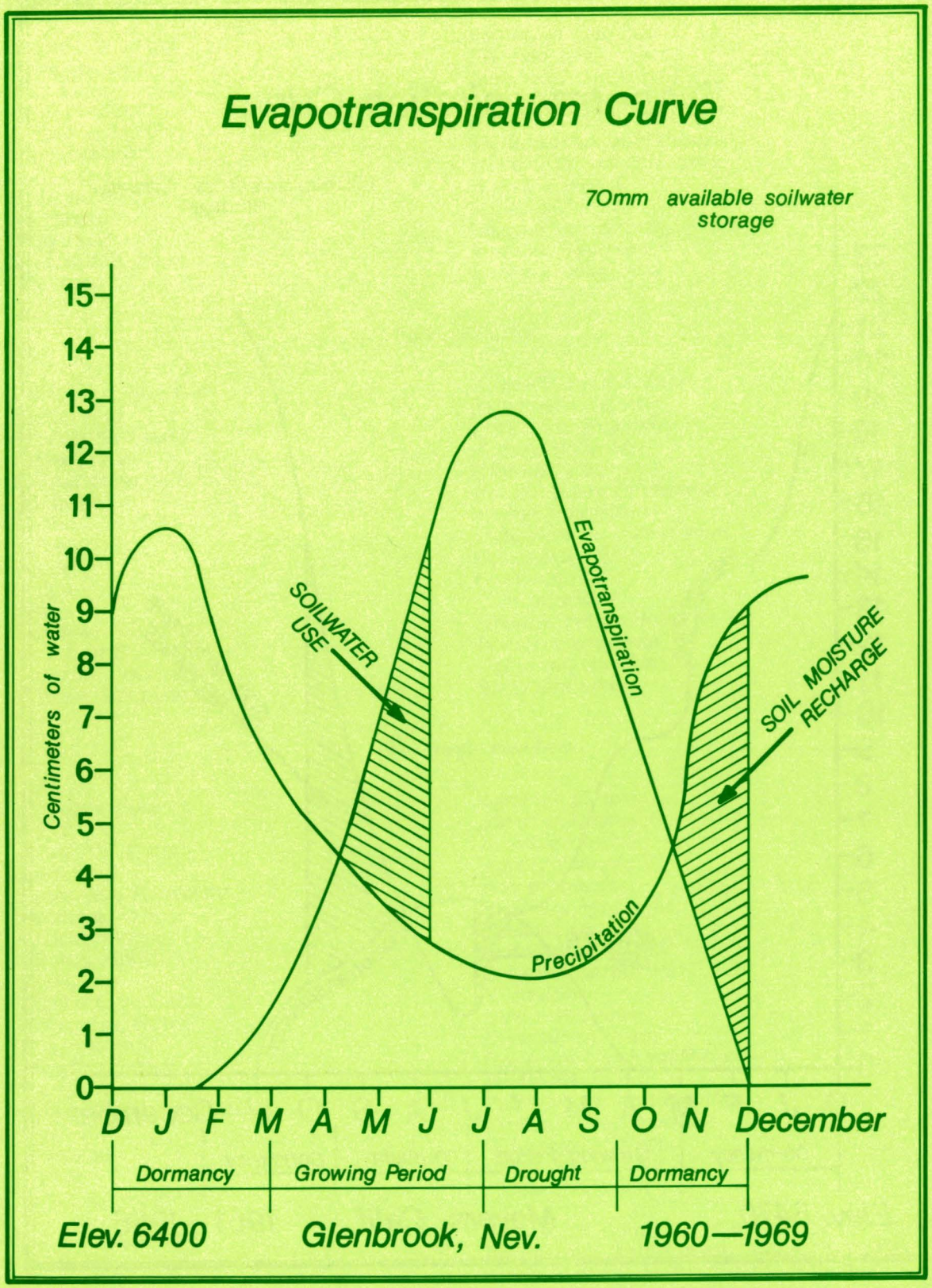


Fig. 2 - Evapotranspiration curve for the period 1960 to 1969 at Glenbrook, Nevada.

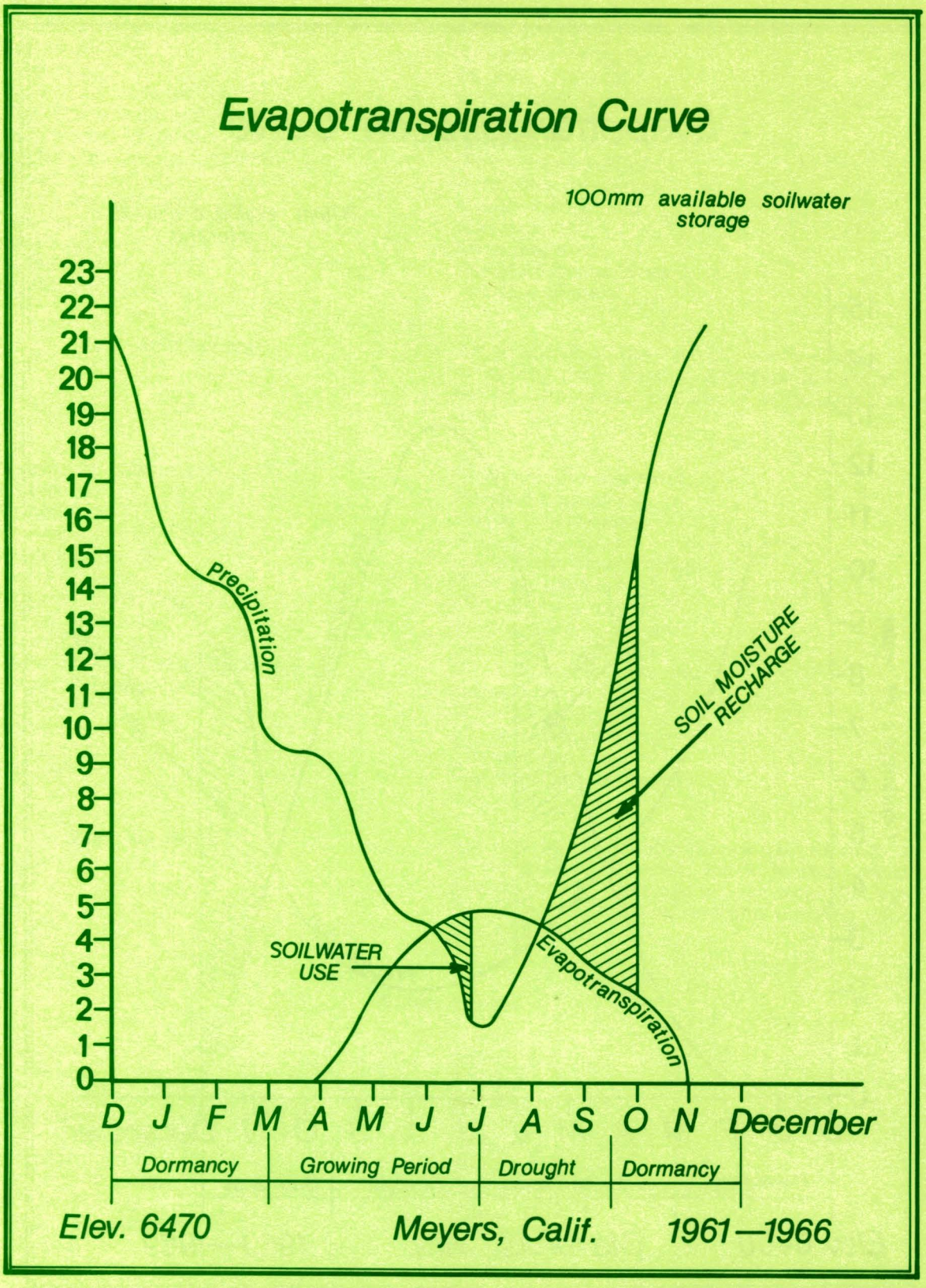


Fig. 3 - Evapotranspiration curve for the period 1961 to 1966 at Meyers, California.

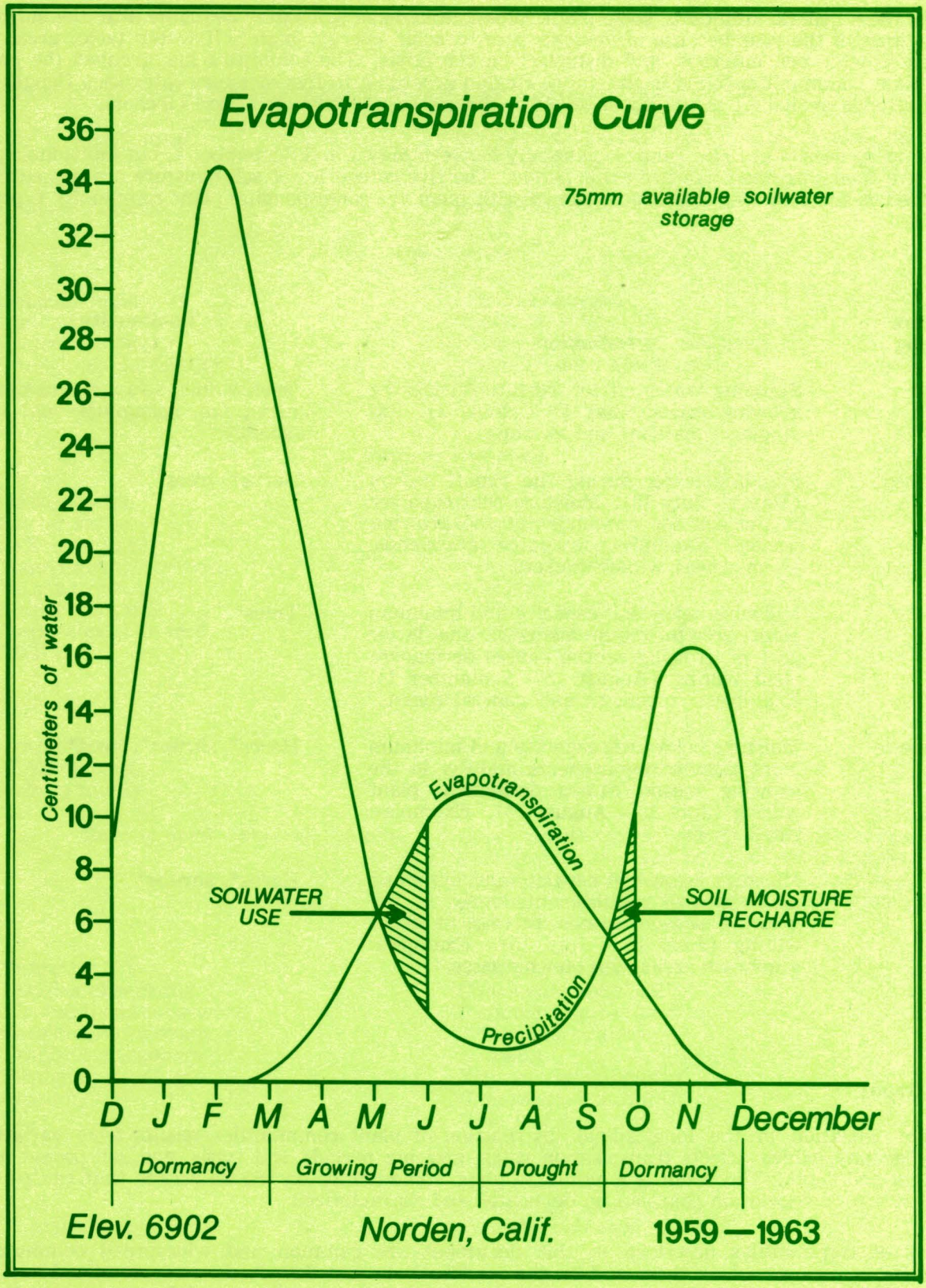


Fig. 4 - Evapotranspiration curve for the period 1959 to 1963 at the Snow Laboratory near Norden, California. Note the mid-winter drought period that is characteristic for much of northern and central California.

Within these general situations, some plant communities have soil water available near the surface at all times of the year because of low exposure to solar energy, high soil water table, areas of late snowmelt, rock outcrops, and disturbed barren areas. The committee has grouped the principal plant communities found in the Tahoe Region according to five moisture categories (length of time water is available) in the upper levels of the soil (usually the top 12 to 18 inches).

The growing season at Lake Tahoe is generally between May 1 and September 1, but individual species have their own seasons within this period. The five categories of soil moisture are named and described in the following tabulation; shown with them are corresponding plant community types.

Moisture category	Definition	Community type
Hydric	Standing water on soil surface during the growing season (May 1 - October 1). Examples: marshes and swamps.	Open water; swamps and pools; carex fen, sphagnum bog; wet meadow*
Wet mesic	Standing water during the runoff season (May 1 - July 15). Moisture near capacity of the soil for remainder of the growing season. Examples: irrigated grasslands, aspen groves, willow thickets.	Herbs*, trees*
Mesic	Moisture below soil capacity and minimum plant growth requirements in the latter part of growing season causes permanent plant wilting (August 15 - September 1). Examples: meadows and general forest.	Trees*
Dry mesic	Moisture below soil capacity and minimum plant growth requirements midway in the growing season causes permanent plant wilting (July 15 - August 15). Examples: shrub types.	Herbs*, shrubs*, trees*
Xeric	Moisture below soil capacity and minimum plant growth requirements early in the growing season causes permanent plant wilting (June 15 - July 15). Examples: sagebrush areas with bunchgrasses.	Herbs*, shrubs*

Topography

Further variation in the longitudinal distribution of plant communities results from variation in topography, which affects transpiration rates, growing periods, soil types, and soil parent material, or soil depth. The result is a mosaic of plant communities on the landscape that contribute to a pattern of vegetation that can be delineated and characterized.

The plant communities described in this document are common and widespread community types, but superimposed on them and on the modifications just described, are successional modifications which are part of a dynamic process of vegetation change; these modifications result from disturbance either natural or man-caused, and are not yet clearly defined nor understood. The Institute of Ecology at the University of California, Davis, is now attempting to describe these changes and relate them to the impact of man-made or natural causes.

Unusual plant community

The Freel Peak-Job's Sister area contains a small but scientifically significant plant community (fig. 5). The plant community on these high, dry windswept ridges, the highest in the region, is a small outlier of a highly distinctive community of cushion plants that is best developed on the eastern crests of the Sierra from Yosemite National Park south to the Mammoth Lakes area. The community near Freel Peak is the only known example north of Tioga Pass except for one on the summit of the Sweetwater Mountains east of the Sierra.

The most distinctive species in this community are the alpine parsley (*Podistera nevadensis*), cushion phlox (*Phlox covillei*), dwarf ragwort (*Senecio werneriaefolius*), and four species of *Draba*, a group of arctic-alpine plants of the mustard family.

This community descends to the 10,000-foot contour on both Job's Sister and Freel Peak, but on the ridge between them it is found only at 10,400 feet and higher. Consequently, if a ski area were developed in this region, it could be compatible with the maintenance of the ridges as a natural or botanical area, provided that construction of installations were confined to altitudes below 10,000 feet within the canyon between the two peaks.

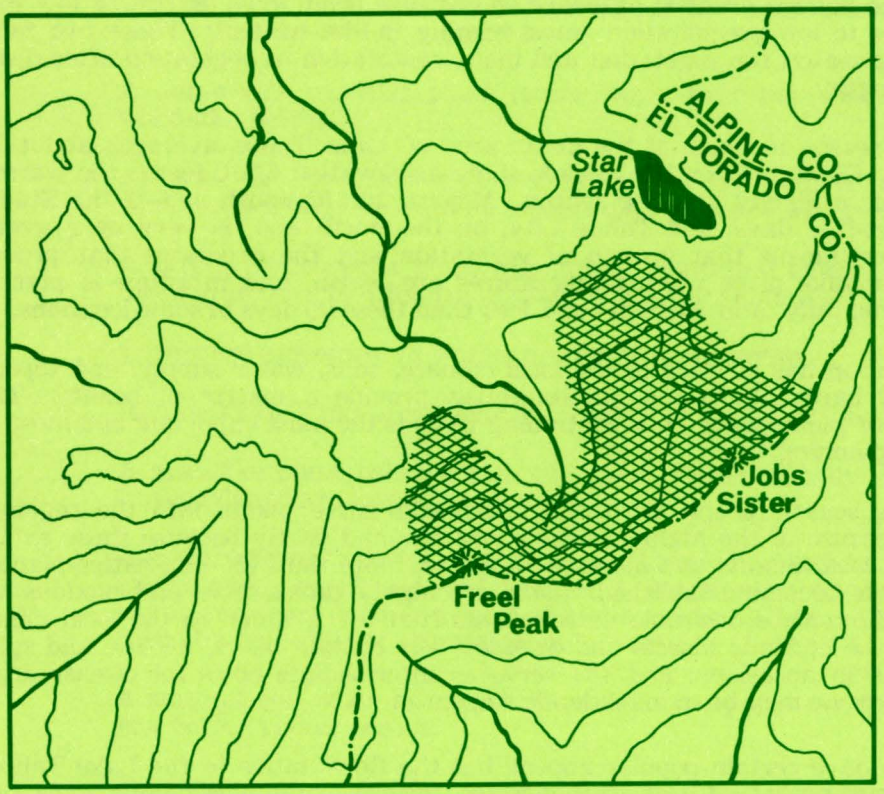


Fig. 5 - Location of unusual plant community on ridges near Job's Sister and Freel Peak.

*Climax type

IMPORTANCE OF VEGETATION IN THE ENVIRONMENT

The literature of planning includes little information about the amenity values of plants, but as we learn more about them — their anatomy, physiology, and reactions to surroundings — we come to realize that plant life can be significant as a planning tool. The **Journal of the American Institute of Planners** (November 1970) discussed the capacity of plant communities to reduce noise and air pollution. Other publications give information about the relation of vegetation to water supply, microclimate, soil management, growing conditions, and landscape integrity.

Since trees and other ground cover can absorb and reduce intensities of sound, transportation routes should be located to pass through certain vegetation types that are known to lessen noise of traffic. Some plantings can be arranged so as to deflect sound. Both of these should be considered when routes for through traffic have to be planned to pass near residential areas.

Foliage intercepts and filters certain aerosols and gases, and this can appreciably lessen the concentration of certain air-polluting gases.

Day-to-day weather conditions in a small area within a vegetation type are influenced by plant associations. For example, during a year's time the range of temperature is much narrower at a given level in a coniferous forest type than in a deciduous type because the deciduous trees (e.g., aspens and maples) shed their leaves in the fall and thus reduce interception of sunlight. Obviously, if an area should be partially shaded in summer and open in winter, broadleaf plantings would be desirable.

Growth of vegetation depends upon prevailing growing conditions. In the Lake Tahoe Region the climate (which has the greatest influence on growing conditions) is one of low mean temperature, with moderate to low precipitation (most coming in the winter). These two factors spell a very short growing season for vegetation and make restoration of vegetation after disturbance difficult, costly, and lengthy.

The growing season in much of the urban area of Lake Tahoe averages about 70 days per year without frost. Glenbrook, on the Nevada shore at elevation 6,230 feet is the warmest area on Lake Tahoe and has a 90-day growing season. Meyers, at the south end of the Study Area, has only about 60 frost-free days; and Tahoe City, on the north end, is very near average[1]. This short growing season means that growth of vegetation and the processes that promote soil fertility, which have to take place when temperatures are warm, and moisture is present, are therefore limited to June, July, and August—and less than these 90 days in some locations.

Native vegetation has adapted to the local climate, soils, water supply, and topography to form a community of hardy plants and simultaneously provide a matrix of beauty. The importance of maintenance of plant cover on a continuing basis is the most important and most economical aspect of landscape planning.

Each planting season, people try to introduce non-native plants into the region and consistently fail, partly because of the highly variable weather and partly because these exotic plants lack defense against local insects and diseases. Even so, more than 150 non-native plants have been introduced and have become established. Many are highly undesirable and noxious weedy species because they (1) replace desirable native plants that are adapted to the local climate and soils and can tolerate the endemic insects and diseases; (2) contain burrs, nettles, and spines that cause irritation and skin abrasions; and (3) serve as intermediate hosts for disease organisms that have not existed here or may be in an endemic stage.

Exotic plants have certain popular appeal, but the flora native to the Lake Tahoe Region give the only solid assurance of natural aesthetics (as opposed to the synthetic ones produced by plant manipulation) and a relatively stable ecological system. Regionwide action barring most imported species and encouraging the propagation, restoring, and replanting of native species should be undertaken. Such action would be the most inexpensive practice because it would require less expense

1 Weather records from U. S. Weather Bureau stations at Glenbrook, Meyers, and Tahoe City.

(for controlling pests, using extra fertilizer, and burning weeds) and would give the most return in scenic value.

Trees significantly reduce wind velocities at or near ground level; establishment of trees in rows having graduated heights has long been used to reduce high winds around farm buildings. Wind action should be studied carefully before any cutting of vegetation for ski-run clearing at proposed large ski areas.

Land values in the Lake Tahoe Region depend heavily on maintenance of the landscape integrity and protection of its natural beauty. Since the vegetation mosaic is influenced by the productivity of the soil, the soil must be conserved. For too long, indiscriminate, excessive, and improper removal of vegetation has been permitted; it has caused soil displacement and serious damaging siltation of streams and the Lake.

Plants are closely associated with water quantity and quality. The "water cycle," which is the interchange of water with air, plants, and land is vital to all living organisms. It involves evaporation, transpiration, cloud formation, precipitation, surface water runoff, percolation, and accumulation (see fig. 6). Removal of vegetation typically increases surface runoff and streamflow. Most soils in the Tahoe Region lose stability when stripped of vegetation; in fact, on many steep slopes there is too little vegetation to hold the thin coarse soil against wind and rain. In such areas precipitation does not remain on the site, and quantities of silt find their way into streams and produce turbid, low quality water. This releases nutrients to Lake Tahoe and contributes to the increasing problem of lake eutrophication and the destruction of important habitat for fish and wildlife.

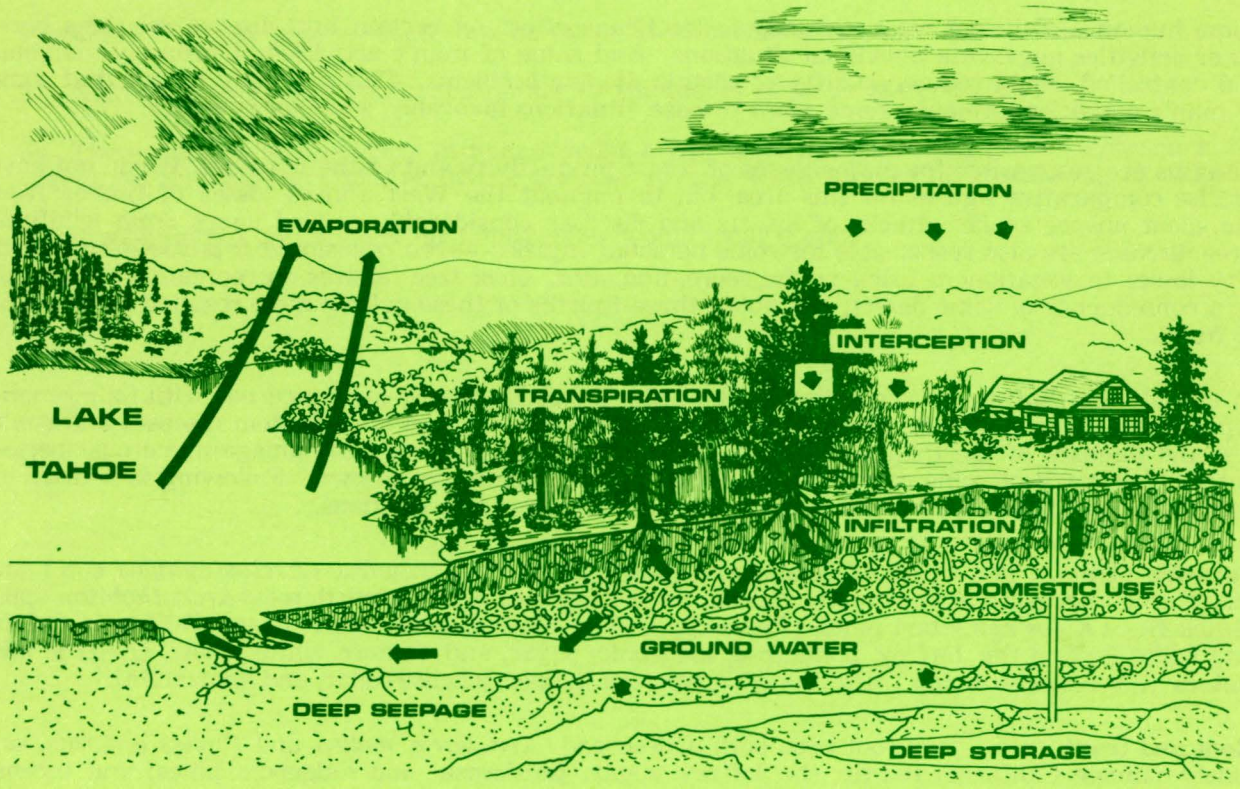


Figure 6. - Schematic representation of the water cycle in the Lake Tahoe Region.

HAZARDS TO VEGETATION IN THE LAKE TAHOE REGION

Vegetation, like wildlife and the human population, is subject to a variety of hazards. These diverse threats to its continued productive existence may be divided roughly into natural hazards (chiefly insects and diseases) and man-caused hazards (various disturbances, including pollution). Description and discussion of these hazards are accompanied by comment on severity and consequences.

NATURAL HAZARDS

Diseases

Diseases of forest trees and other associated native plant species in the Tahoe Region are generally the same as those found elsewhere on the eastern slope of the Sierra Nevada range. Some are common and widespread and strongly affect the species they attack. Others occur rarely or sporadically and without disturbance and are unusual biological curiosities rather than dangerous agents of disease. The information presented briefly here was compiled from forest disease surveys, herbaria, and knowledge of the plant disease situation in California generally and in and around the Tahoe area. Conclusions drawn from man's influence on the plant diseases and their potential are judgments based on knowledge gained in other areas and under less intense man-use situations.

The diseases discussed here are only those that attack trees and shrubs listed in the Appendix; they are part of an inventory compiled by the Pacific Southwest Forest and Range Experiment Station (U. S. Forest Service) at Berkeley, and full information about them is on file at the U. S. Forest Service office at South Lake Tahoe, California.

Diseases of grass were not included on the list because of the diversity of species in this region and the large number of diseases occurring amongst them. The most damaging hazards to grass types in the Region would be as direct results of such human activities as raising or lowering the water table and compacting the soil.

Some human activities have a virtually insignificant effect on certain host-disease relations here; other activities aggravate individual situations. And some of man's activities, if properly managed and controlled, could reduce severity of certain disease problems. This is simply to say that some of man's activities influence some plant disease situations favorably, some unfavorably.

Diseases are responsible for major losses of forest productivity and aesthetic values. We do not have precise comparative figures for this area, but throughout the West annual losses of timber from the silent unspectacular attacks of insects and diseases considerably exceed losses from wildfires. Tree diseases are also responsible for some personal injuries—even occasional fatalities—and property losses to vacationers using public recreation sites. Most tree failures on recreation sites occur as a consequence of some defect, and about three-fourths of these defects have resulted from action of fungi.

In considering diseases of vegetation in the Lake Tahoe Region we are concerned with four general types of organisms; namely, parasitic plants, rots of tree roots and trunks, stem diseases and cankers, and diseases of the foliage. Many of these organisms are known to damage numerous species, but the full scope of some organisms' potential for damage is not known. Following is a brief inventory of what has been learned about several host-organism relations.

Parasitic plants. Two types of **dodder** are known to infect manzanita (*Arctostaphylos* spp.) and many other herbaceous and woody plants. Several species of **dwarfmistletoe** (*Arceuthobium* spp.) attack firs (*Abies* spp.) and pines (*Pinus* spp.). The chief species attacked are California red fir and white fir and the Jeffrey, ponderosa, lodgepole, sugar, and western white pines. The true **mistletoes** (*Phoradendron* spp.) are found on western juniper, incense cedar, and manzanita.

Root and trunk rots. Two root rots, both widespread, *Armillaria mellea* and *Fomes annosus,* seriously damage California red fir; the Jeffrey, sugar, ponderosa, and lodgepole pines; and incense cedar. Various other species of root rot also attack alder, aspen, willow, juniper, and manzanita with various degrees of severity. The two species of firs and most of the pines already mentioned

are subject to damage from *Polyporus* spp. and a few other rots. The firs are also damaged by Indian paint fungus (*Echinodontium tinctorium*).

Stem diseases and cankers. Several tree diseases widespread throughout the West are known to have hosts in the Tahoe area. The stalactiform rust (*Cronartium coleosporiodes stalactiforme*) is known to attack and damage the lodgepole and Jeffrey pines; other hosts are Indian paintbrush (*Castilleja* sp.) and bird's beak (*Cordylanthus tenuis*). Two other **Cronartium** species are present in the Region (*occidentale,* pinyon rust, and *ribicola,* white pine blister rust), but the extent of their occurrence and damage appears to be minimal.

Of special importance among the rusts are the limb rust, *Peridermium filamentosum,* and western gall rust, *P. harknessii.* They both damage the Jeffrey and lodgepole pines, and *P. harknessii* also attacks ponderosa.

Cytospora chrysosperma causes elongated brown-stained canker-like lesions on aspen and cottonwoods (*Populus* spp.); it also infects some willows (*Salix* spp.), and its relative *C. abietis* is known to damage both white and California red fir. The fungus *Exobasidium vaccinii,* which produces "false blossom" on certain heath plants, notably cranberry, has been found on two species of manzanita. *Dothiorella,* another fungus, has manzanita and saltbrush (*Atriplex canescens*) as hosts.

Some foresters feel that the root rots, dwarfmistletoe, and the stalactiform and western gall rusts may not be especially serious by themselves but may be disposing many of the conifers to attack by bark beetles.

Foliage diseases. This group is somewhat more numerous than those already mentioned, but less is known about the extent and seriousness of damage they cause to various species. Most of these diseases are blights or rusts.

Probably best known of the blights is *Elytroderma deformans,* a widespread needle blight that seriously damages the Jeffrey and ponderosa pines. Two varieties of brown felt blight damage two different groups of conifers. *Neopeckia coulteria* is found in lodgepole, Jeffrey, sugar, and other pines. *Herpotrichia nigra* damages white fir and California red fir, incense cedar and other cedars. Two species of *Septoria* and *Phyllosticta* are found in western alder.

Several rusts known to be in the region are generally specific to a single host. *Melampsora albertensis* is found in aspen; *M. bigelowii* infects willows, while *Melampsoridium alni* is in alder. *Phragmidium occidentale* is a rust on thimbleberry. Four species of *Puccinia* are found in various amounts on Stephanomeria, Ribes, Monardella and Artemisia; but *Pucciniastrum geoppertianum* infects white fir.

Melampsorella caryophyllacearum, the yellow witches' broom, seriously damages the two major fir species already named and is widespread. Two closely related needlecast diseases, *Lophodermella arcuata* and *Lophodermium pinastri* are known to be present in sugar, lodgepole, ponderosa, and Jeffrey pines.

Several other diseases of foliage of native plants are known, but since information about them is at best sketchy it seems to have doubtful value in this planning guide. However, one point worth emphasizing is that extreme caution should be used in introducing new or exotic species into the area. In the past, extremely damaging epidemics of diseases have been started—and these are usually uncontrollable—by introduction of new host plants into an area of wildland.

Insects

Insects have been called the world's foremost opportunists. They populate the land with the greatest assemblage of species of any group of organisms. In the Lake Tahoe Region some 150 different species were identified by Fred Roberts, entomologist from El Dorado County, and information about them is on file with the U.S. Forest Service, South Lake Tahoe, California. Generally they are a natural and necessary component of the Tahoe ecosystem. Their role as pollinators, scavengers, food supply for certain wildlife and fish species, and regulators of pest insect populations is not only beneficial but essential.

Is is beyond the scope of this publication to catalog all the insects found in the Tahoe region—for that matter, even to list all insects in the area that injure or destroy trees and other plant life. The following pages summarize types of insects, usual types of their hosts, and the kinds of damage they do.

Beetles (Order Coleoptera) are the most numerous group and the most destructive. Within this class the Scolytidae family (24 species) is especially prominent. Scolytidae generally attack conifers. Some species (notably *Dendroctonus*) kill trees; others attack and kill limbs; others merely weaken the trees so that they are vulnerable to attack by other insects or by disease. The genus *Conophthorus* damages cones. The Buprestidae family (17 species) also attacks conifers, but most of them merely weaken the trees. Some buprestids also find hosts in willows, aspen, gooseberry, and manzanita, where they generally kill twigs. The Cerambycidae (15 species) find hosts variously among the pines, the two native firs, cedars, willows, and aspen; they, too, generally either weaken whole trees or kill twigs. Weevils (8 species) are widespread among the conifers, chiefly in the pines and firs, but also in willows. One species, *Rhodobaenus tredecimpunctatus,* has the California thistle (*Cirsium californicum*) as host. The weevils mainly kill or weaken twigs and terminal shoots and small branches, but *Brachyrhinus* spp. damage roots of seedlings of all conifer species. The Chrysomelidae family (6 species) find hosts in willows, aspen, phlox, and asters, where they feed variously on leaves, petals, and flowers.

Scale insects, which suck sap (18 species), generally weaken but do not directly kill their hosts. Two-thirds of these species confine their damage to the conifers, mostly pines; the others feed variously on aspen, willows, and the wild gooseberries and currants. The spider mites (*Oligonychus* spp.) work mostly on lodgepole pine.

The Order Lepidoptera (caterpillars and moths) are defoliators that attack a few tree species and several shrubs and forbs. More than 50 species of Lepidoptera have been identified in the Tahoe area. By destroying leaves they reduce their hosts' capability for photosynthesis and thereby weaken them and make them vulnerable to attack by other insects and diseases. The cone moths (5 species), which have hosts in pine and fir species, may reduce natural regeneration by destroying seeds.

Miscellaneous insects include two species of flies (*Lonchaea viridana* and *Retinodiplosis* spp.) that respectively (1) mine the seeds and thereby reduce regeneration of white fir and (2) attack the lateral tips of ponderosa pine. Four wasps and sawflies variously attack species of pines and willows.

The foregoing descriptions and discussion of natural hazards to plant life in the Lake Tahoe Region is that and nothing more. Certain practices in timber management are known to ameliorate certain conditions conducive to the spread of certain tree diseases; conversely, others accelerate spread. The control of insects is a complex problem because of the varied ways in which they attack trees. Considerable research by the Forest Service and allied agencies during the past three decades has been directed toward learning details of the life history of destructive insects so that effective means of control could be devised. Unfortunately, some techniques that initially seemed to promise much have had to be abandoned; notable among these was the aerial spraying of DDT for controlling extensive epidemics of certain forest insects. The chemical formulation was effective, but its persistence resulted in undesirable side-affects on forest ecology. Research currently emphasizes possible development of biological controls, but results to date can best be characterized as tentative.

MAN-CAUSED HAZARDS

Besides the natural hazards to vegetation in this area, there are others directly attributable to a variety of human activity conveniently called "urbanization." After listing the hazards attributable to the phenomenal increase in local population, it became apparent that they could be grouped roughly as "disturbances" of the physical environment and "pollution," essentially a specialized type of disturbance.

Disturbances

Vegetation is superficially regarded as merely a visual element of an ecosystem; its role actually penetrates all facets of ecology.

The 11 types of disturbance listed on the following pages and their pertinence to detrimental effects on vegetation resulting from human activities are a critical identification source of potential problems. These kinds of disturbance and their effects should be studied by all persons involved in planning land uses. These kinds of disturbance are classified broadly as direct and indirect. Within these two classes they are further classed as permanent, temporary, and seasonal.

Plants respond directly to climate (moisture and temperature), gravity, light, chemicals available to their photosynthetic activities, and surroundings, especially other plants. They seek light, orient their roots and stems as gravity dictates, and search out nutrients and water in the soil. They adjust quite closely to their surroundings and are constantly competing for the life-supporting elements. The response mechanism of some plants can be affected by slight changes, but others can withstand great environmental alterations.

Identifying the capability of each of the Lake Tahoe region's 700-odd plants to withstand disturbance would be a wasteful exercise because many species are similar and react in close accord with the environment prevailing in their plant community rather than by species type. Six levels of impact have been identified and developed, as explained in the following list. The list is intended as a general guide to planning so that various forms of environmental disturbance can be more readily understood in relation to their effects on ecological systems. This list should not be scrutinized for final detailed environmental guidance, but should be viewed as an introductory or synoptic presentation of the varying degrees of disturbance that affect the region's plant environment.

Direct, permanent impacts are influences on the vegetation that are exerted directly on a specific element in the plant's immediate environment and are expected to have a lasting effect. Examples: surface soil compaction, clearing land, introduction of exotic vegetation.

Direct, temporary impacts are influences on the vegetation that are exerted directly on a specific element in the plant's immediate environment and are expected to occur only during one period of time or on an occasional basis. Examples: grading, motion, use of burning to eliminate refuse.

Direct, seasonal impacts are influences on the vegetation that occur only during a specific time of the year or as the result of certain seasonal occurrences. Examples: clearing land, introduction of exotic evegetation.

Indirect, permanent impacts are influences upon a given aspect of the vegetation as the result of affecting another interrelated part of the environment. Examples: surface soil compaction, noise, unaccustomed motion.

Indirect, temporary impacts are also influences upon a given aspect of the vegetation as the result of affecting another interrelated part of the environment. These influences would occur during only one period of time or on a single occasion. Examples: noise, climatic change, certain uses of chemicals.

Indirect, seasonal impacts influence a given phase of the vegetation as the result of affecting some other interrelated part of the environment. These influences would occur during a certain time of the year or as the result of certain seasonal occurrences. Examples: grading, insect and disease operations, burning.

Many of the land impacts that have occurred thus far in the history of Lake Tahoe's urban development have required clearing and alteration of the native vegetation.

TYPES OF SOIL DISTURBANCE AND THEIR EFFECTS

1. **COMPACTION OF SURFACE SOIL:** reduction of open pore space

   Biogeochemical cycles altered: Carbon, Nitrogen, Phosphorus, and Water

   Effects on the natural ecosystem:

   1. Interrupts the leaching of carbon into the soil.

2. This destroys nitrogen-fixing soil bacteria.

3. This, in turn, prevents interchange of water between land and atmosphere.

4. Depletes nutrients through surface runoff.

5. Restricts leaching of nutrients.

6. Restricts leaching of phosphorus.

Years of complex interplay between many plant species eventually produce the proper degree of compactness in a soil. Repeated traffic compacts normally loose soils; it produces a hard surface layer and causes the soil to become firm and dense. This condition can be instigated by location of roads, emplacement of parking areas and structures, the operation of heavy equipment, and even intense pedestrian traffic. It decreases water penetration and gas diffusion into soils; this may lower the resistance of plants to certain insects. Most compaction usually occurs in the top few inches, and since most of the nutrient-gathering rootlets of trees are within 1½ inches of the soil surface, compaction is detrimental to the tree. Heavy soils (high clay content) are more vulnerable to compaction than light soils.

2. **CLEARING:** Removal of surface vegetation

Biogeochemical cycles altered: Carbon, Nitrogen, Nutrient, Oxygen, Water

Effects on the natural ecosystem:

1. Drastically reduces or may eliminate photosynthesis.

2. Stimulates an unnatural increase in carbon input to the soil through plant decay.

3. Destroys nitrogen-fixing bacteria that live in nodules of live plants.

Cutting a road through a forest not only kills the trees and other vegetation in its path but it may endanger nearby trees as well. Some ways in which these trees may be threatened are: **sealing,** where pavement covers the root spread; **fills,** required for engineering rights-of-way; **road cuts,** which may damage roots or lower the water table; **increasing erosion,** such as erosion from an embankment of the natural ground cover, which results in the accelerated runoff of water and may prevent needed water from reaching roots; and **exposure,** by changing the intensity and direction of windflow by creating an artificial canyon with a roadway. In determining the location of buildings, care should be taken to obtain a "globular" effect rather than a "linear" effect. This positioning can reduce the possibility of exposure to the trees in the area and can prove to be an aesthetically pleasing and environmentally responsive way to develop. It can also be more easily adapted to natural clearings that already exist.

3. **GRADING:** All soil-moving operations, both surface and subsurface

Biogeochemical cycles altered: Carbon, Nitrogen, Nutrient, Phosphorous, Water

Effects on the natural ecosystem:

1. Liberates carbon locked in the new soil horizons (litter and A).

2. Releases nitrogen stored in soil.

3. Alters normal patterns of percolation and surface runoff.

4. Nutrients are lost from the ecosystem when the humus layer is disturbed.

5. Releases phosphorus stored in natural rock deposits.

Some trees are severely affected by a change in soil-moisture conditions, especially by alteration of depth of the water table. Lowering the grade may lower the water table; this can result in excessive drying of roots. Earth fills may raise the water table, thereby increasing the moisture content and reducing the oxygen content of the soil to the point that roots suffocate. Another common problem is the creation of cold ponds. Heavy cold air flows downslope and collects in newly created bottoms. Resultant temperature changes may adversely affect plant cover.

4. **IMPERVIOUS SURFACES:** placement of impervious surfacing material on top of natural or imported soils.

   Biogeochemical cycles altered: Carbon, Nitrogen, Nutrient, Oxygen, Water

   Effects on the natural ecosystem:

   1. Removes carbon compounds from circulation.

   2. Cuts off supplies of nitrogen and oxygen to and from the soil.

   3. Cuts off the nutrient supply to the soil.

   4. Completely eliminates infiltration of water into the soil, and thus increases the quantity and velocity of runoff water.

5. **NOISE:** Noise rating of more than 75 decibels at 100 feet and the intrusion of noise in an area previously quiet.

   Biogeochemical cycles altered: None known.

   Effects on the natural ecosystem:

   1. Most animal species react unfavorably to unaccustomed noise within or adjacent to their habitat.

Noise prevention is an important consideration in any development. Noise, in mostly an indirect manner, can adversely affect the growth patterns of vegetation and wildlife. The relation between avalanche hazard and noise is well known. Highways are a linear source of noise; air traffic patterns and sonic booms influence the environment; so do any explosives used in development. Vegetation can be used effectively to screen out excessive noise and protect the surrounding area from its adverse effects.

6. **MOTION:** movement associated with wheeled vehicles, boats, planes, people, snowmobiles, etc.

   Biogeochemical cycles altered: None known

   Effects on the natural ecosystem:

   1. Most animal species react unfavorably to unaccustomed noise within or adjacent to their habitat.

Many forms of motion can be destructive, directly or indirectly, to the surrounding environment. One kind of motion that should be considered is shock, both above and below ground. Shock can be caused by sonic booms or compression forces resulting from explosions. Another type of motion which can be destructive to the environment is vibration. The continual shaking caused by all types of machinery or by people can result in abrasion. An example of this type of damage would be rocks continually being rubbed against plant parts above or below ground. Vibration can also extend compaction to areas beyond direct mechanical contact. Severe vibration can result in "slurry," literally reducing soil to a liquid.

7. **CLIMATIC:** changes associated with natural climatic conditions of wind, snow, rain, etc.

Biogeochemical cycles altered: Carbon, Nitrogen, Nutrient, Oxygen, Water

Effects on the natural ecosystem:

1. Flora and fauna native to the Lake Tahoe Region have undergone genetic assimilation to normal climatic changes: hibernation, migration and/or reduced activity.

2. Material cycling (carbon, water, nutrients, etc.) is almost at a standstill, and most wildlife species must survive by adjusting.

In mountainous areas like the Tahoe Region, climatic conditions can vary greatly within relatively short distances. Air flow tends to be channeled by the moutnains, while differences in heating due to variety of surface features (vegetation, water, rocks, and soil) and orographic effects upon cloud and precipitation patterns all contribute to a complex climate. This intricate exchange between land and air can be easily upset locally by topographic changes and development. Cutting a roadway through a dense forest or removing large numbers of trees may radically alter the direction and intensity of the wind flow in the tree canopy. Instead of striking the canopy as a whole, the wind rushes through artificial canyons at a rate of speed that the remaining trees and root systems have not adjusted to. Trees that formerly grew in shade and that are suddenly exposed to sunlight, drying winds, and to more radical temperature changes often die, come under stress, or are badly damaged mechanically. On the other hand, the construction of buildings may block sunlight. Some native species of plants are intolerant to shade and would be adversely affected. Care should always be taken to preserve the natural protection against wind provided by the tall trees and terrain and to consider effects of shade and radiation on later plant growth.

8. **INSECTS AND DISEASE (OPERATIONS):** this includes the normal insect and disease control operations that prevent epidemics that extensively damage flora and fauna.

Biogeochemical cycles altered: Carbon, Nutrient

Effects on the natural ecosystem:

1. Insect infestations interfere with and/or interrupt functioning of the carbon cycle.

2. Successful prevention methods increase the return of nutrients to the soil.

3. Improper insect or disease prevention methods may harm ecologically valuable insects and plant life.

Trees are subject to attack by numerous insect pests and diseases. Forest insect pests of primary importance in the Tahoe Basin all belong to the family called "bark beetles." Those causing the most destruction are the Jeffrey pine beetle, the mountain pine beetle, the pine engraver beetle, the turpentine beetle, and the fir engraver. Pine trees have a natural ability to overcome bark beetle attacks if their vigor is maintained and if bark beetle populations remain below epidemic levels. However, if a tree's vigor is reduced by old age or lack of moisture, an injury to or loss of a branch, fire injury or soil disturbance, it may lose its resistance to attack. Diseases caused by fungi, parasitic plants, and physiogenic disturbances such as wind, ice, snow, drought, lightning, and construction damage take a heavy toll of trees each year. These diseases can kill trees or weaken them so much that they become prey to insect attack or victims of windthrow or breakage due to increased snow or ice load. The most prevalent tree diseases in the Tahoe Region include dwarf-mistletoe, heart rots, elytroderma needle disease, root diseases, and stalactiform limb rust.

9. **EXOTIC VEGETATION:** introduction and maintenance of plant species not native in the region.

Biogeochemical cycles altered: All cycles.

Effects on the natural ecosystem:

1. Introduced plant species have not undergone genetic assimilation to the environment and are very susceptible to insect and disease infestations.

2. Exotic species may successfully resist infection, but could still be excellent intermediate hosts.

3. To become established, most introduced plant species require excessive growth stimulants and water.

4. Adjustment to the cyclic process may be difficult or impossible when climatic variations occur.

Introduction of exotic vegetation could bring in insect and disease hosts and organisms that might upset the balance of native plants by creating competition. An introduced species may become a weed pest or may be a host to existing endemic organisms. Maintenance of these introduced species can result in the artificial use of heat and water, which may create secondary environmental problems. However, where native plants may be intolerant to man's alterations and activities, a careful selection of replacement vegetation may help maintain a natural balance of plant life in the area.

10. **USE OF CHEMICALS:** application of chemicals for soil fertilization and mosquito abatement.

Biogeochemical cycles altered: Carbon, Nitrogen, Nutrient, Phosphorus

Effects on the natural ecosystem:

1. Extensive use of growth-stimulating chemicals may alter or supplant the normal flow of energy; i.e., carbon, nitrogen, nutrients, and phosphorus.

2. Plant loads begin to exceed normal soil capacities; this interrupts various cycles and reduces their effectiveness in the biological network.

3. Improper methods of insect or disease prevention may harm ecologically valuable insects and plant life.

Insecticides, when used nonselectively, may adversely affect plant growth and may reduce populations of beneficial predatory and parasitic insects. Their herbivore insect host may then increase in numbers, dramatically upsetting the delicate balance of the ecosystem. In the application of artificial fertilizers, care in administering the proper amounts to prevent losses from runoff or leaching is another important caution to remember. Salt has been added to the environment through its use on roadways to facilitate ice removal. Concentration of salt around bases of trees during periods of snow removal or melt is damaging.

11. **CONTROLLED BURNING:** elimination of vegetative debris and litter by burning.

Biogeochemical cycles altered: Carbon, Nitrogen, Nutrient, Oxygen

Effects on the natural ecosystem:

1. Burning releases carbon from the protoplasm of plants much more quickly than the natural process of decay of organisms.

2. Can destroy the nitrogen-fixing bacteria in the soil.

3. Momentarily cuts off the soil's oxygen supply and destroys organisms living in the soil.

4. Provides a quick release of nutrients found in litter.

Selective elimination of vegetative debris and litter by burning may create many problems, such as fire hazard, loss of aesthetics, loss of wildlife habitat, loss of needed soil-stabilizing vegetation, and air pollution. However, survival of some species depends on a major shock, such as a fire, to cause seed germination.

Air pollution

The two major processes carried out by plants are **photosynthesis** (mixing light, energy, water, and carbon dioxide to form sugar and oxygen) and **respiration** (breaking down the sugar with oxygen, thereby releasing energy absorbed from light, with carbon dioxide and water as byproducts). Plants are very sensitive to changes that affect these processes and to certain intensities of air pollutants.

Literally hundreds of pollutants can be detected in the air. Some have already been identified in the Lake Tahoe Region. The most important and the one that causes most plant damage is ozone (0), a highly toxic, unstable molecule produced from photo-oxidation and reduction of the various elements in automobile exhausts. Ozone gas is absorbed with moisture through the leaf or needle and, depending upon the quantity and length of exposure, it will either reduce or stop photosynthesis.

Another substance that has been detected in the air at Lake Tahoe is sulphur dioxide (SO). This gas is produced by the combustion of many different forest materials such as needles, leaves, slash, brush, and other woody materials. Combustion processes using oil-based fuels also add much sulphur dioxide to the atmosphere. It requires a greater concentration of sulphur dioxide than of ozone to injure the plant. Damage to vegetation first appears on the underside of the leaves of broadleaf plants; low concentrations of pollutants cause a silvery, dry-looking condition; heavy concentrations give the leaves a burned appearance.

In addition to ozone and other oxides, a third group of pollutants called **peroxyacyl nitrates** is extremely damaging to plants. They, too, are a product of photo-chemical oxidation of hydrocarbons and are added to the atmosphere through burning of organic material and exhaust from internal combustion engines. Needles on conifers turn yellow when forced to absorb these pollutants.

Each time plant tissue is exposed to any of these pollutants, a certain part of the "factory" necessary for food and oxygen production is injured or ceases to function. Tissue does not recover and prolonged exposure causes mortality.

Damage from air pollution is tied very closely to the microclimate of the Lake Tahoe Region. Surface inversions exist about 80% of the nights during a normal year. The depth of these inversions is generally between 100 and 150 feet. Pollutants put into the air are trapped between the ground surface and this inversion layer. If there is no ventilation (wind to blow the inversion out of the Basin), stagnant air conditions result, and plants are intensively exposed to the pollutants. These conditions are most likely to occur between the beginning of April and the end of October, but they occur occasionally in other months.

Two other types of hazards that should be mentioned occur along roadsides and highways. Herbicides and soil sterilants used to kill brush around powerline poles and brush that overhangs roadways can damage other species than those they are used to kill. Pine species appear to be especially susceptible to such chemical formulations. In wintertime, the sandblast affect of having snow and ice particles and undissolved crystals of salt hurled against crowns and foliage by snowplows is evidently injurious.

REVEGETATION

The importance of prompt vegetation of disturbed areas cannot be over-emphasized. Barren areas created by human activity are aesthetically displeasing, and they encourage erosion, which deteriorates the vegetative productivity and hydrologic values of the site. Bared areas discharge silt and nutrients into streams and lakes in abnormal and ultimately deteriorating amounts. Wildlife habitat and grazing for domestic livestock are destroyed. These and other adverse effects must and can be reduced to levels commensurate with what might be termed good land management by prompt, thorough applications of revegetation and regeneration practices.

The Lake Tahoe Region is blessed with numerous species of plants that are both beautiful and useful to man and wildlife. Preservation of this resource is achieved most directly by reducing the possibilities for initial disturbance rather than by attempting to restore an acceptable cover. Detailed techniques specific to the Tahoe Region are still being developed, but we know that certain practices that have proved effective elsewhere under similar ecological conditions will be effective here. These practices, with proper prescriptions designed for each particular situation, may include terracing, scarification, mulching, fertilizing, seeding, planting, and irrigation.

Natural reestablishment of vegetation in the Tahoe Region is at best a very slow process because of the nature of much of the topsoil on slopes and the rigorous climate. To retain watershed and aesthetic values, it is usually necessary to use such artificial methods as planting or direct seeding.

Where native vegetation must be removed, the regeneration of the same cover (or revegetation with other species) will be simplified in proportion to the degree to which the soil is protected during the removal operation. Because surface litter or bare surface soil is required for seedling establishment, it is imperative that soil disturbance be minimized.

The surface foot or more of any soil profile is the most critical and valuable for supporting plant life. It is the richest part of the soil in nutrients, water-holding capacity, and activity of micro-organisms, insects, worms, and other forms of soil flora and fauna. All organisms living in and above the soil environment have come into a natural symbiotic balance over centuries of biological development and adaptation.

The surface soil and the organic litter layer are a reservoir of local native plant seeds. Some seeds can lie dormant in the soil for many years without deteriorating. When the required combination of environmental conditions occurs (principally temperature and moisture), or if the seed coat is scratched by some means, germination occurs. Such disturbances as fire or clearing often start germination, with consequent revegetation by native plants, assuming that the seed reservoir is not completely destroyed or removed.

Seeds of some species do not lie dormant for many years before germinating or decomposing. Many of these require bare mineral soil for seed beds. Seeds of some species have wings or other efficient devices for dispersal and can invade from seed sources outside the disturbed area and thus effect natural revegetation. It is necessary to maintain the top soil-litter layer at disturbed and eroded sites.

Preparation for planting

When vegetation must be reestablished on sites where disturbance has damaged or destroyed ground cover, special effort is usually necessary to achieve successful planting. It is best to seek advice from persons with firsthand knowledge or experience when planning any large-scale planting. Such plans should be made well in advance of the soil disturbance and before start of the growing season. For a given project consideration should be given to:

Kind and amount of site preparation necessary

Costs for site protection and maintenance

Characteristics and limitations of the soil

Limitations on moisture at the planting site

Kinds of plants that are suitable (preferably natives)

What to plant

Grasses. In deciding what to plant, first consideration should be given to the primary objective to be achieved. In the Tahoe Region, grasses are important for prevention of soil erosion. Mixtures of species are desirable for use along roadsides because rapid-growing species can provide temporary cover until slower developing species produce turf. Characteristics needed in grasses are low spreading form (to reduce need for frequent mowing); tolerance for drought; ability to grow in poor soil; resistance to invasion by weeds, and deep roots for effective stabilizing. Species desirable for use in the Tahoe area include bent grass, certain species of brome, tufted hairgrass, bluegrass, alpine timothy, sedges, and some wheatgrasses.

Forbs. Forbs also help protect soil from erosion and have the further advantage of providing feed and cover for wildlife. Forbs in the legume family are especially desirable because they can increase fertility. Native forbs that are both useful and attractive, for their flowers, include asters, columbine, lupines, evening primrose, wild geraniums, clovers, larkspur, penstemon, gilia, wild strawberry, and wild irises. Larkspur and lupine should not be planted in areas that may be grazed by domestic livestock because of danger of poisoning.

Shrubs. Shrubs have demonstrated varied usefulness in hedges, barriers, screening, and soil stabilizing, but they have been difficult to transplant. Some previous difficulties in transplanting have been solved, and numerous native species are adapted to use in the Tahoe Region. They include dogwood, elderberry, manzanita, chinquapin, huckleberry oak, bitterbrush, bitter cherry, honeysuckle, curlleaf mountain mahogany, squaw carpet, wild currant and gooseberry (*Ribes* spp.), and willow.

Trees. For some sites, limited planting of trees is desirable. Sixteen species are native to the Tahoe Region and should be given first consideration for local use, but for any spot the soil and climatic conditions should be accurately known and considered before selecting a tree for planting. The best trees for transplanting in this area are mountain alder, quaking aspen, incense cedar, mountain hemlock, Sierra juniper, and the Jeffrey, lodgepole, and sugar pines, and white fir.

ISSUES AND PROBLEMS

The following issues and associated problems are identified with preservation and enhancement of the vegetation in the Lake Tahoe Region.

I

Issue: Should chemical formulations be used to control epidemics of forest insects and to control diseases, or should they be banned in favor of use of other methods of control (e.g., biological controls)?

Problems: 1. Certain chemicals have proved to be effective, but their extensive application (especially by aerial spraying) has had certain unfavorable effects on the ecosystem of areas where they have been used. These effects have resulted chiefly from lack of selectivity and from long-term persistence of the chemicals.

2. It is sometimes difficult to balance known costs of chemical application against estimated values of areas saved from attack by insects and disease.

3. Problems have arisen regarding authority for regulating chemical applications.

4. Selectivity of some formulations has not been determined precisely.

5. Sometimes field workers have had inadequate instruction or experience in identifying dangerous insects and plant diseases. Resulting faulty identification has resulted in failure to detect a disease or insect hazard or has resulted in application of a treatment where it was not warranted.

6. Identifying possible biological controls is slow and costly, their effectiveness uncertain, and their operation slow.

II

Issue: Should established or potential recreation areas be open to unrestricted public use, or should use of these areas be restricted?

Problems: 1. Many people desire to frequent certain areas because certain kinds of facilities have been installed (e.g., running water, stoves, and sanitation facilities).

2. Local and general increases in population generate increased demand for recreational use of public lands.

3. Creature comforts installed at established recreation areas attract some people who do not properly care for them and who also damage plant life.

4. Unrestricted availability virtually invites vandalism against installed conveniences (e.g., picnic tables, toilets) and against plant life (e.g., cutting live trees for firewood, wholesale picking of wildflowers).

5. If use of an area is restricted, cost of enforcement must be considered; if use is unrestricted, costs are incurred for cleanup and for repair of damage.

6. Tolerance of many plants toward impacts of human use (e.g., trampling) is not yet precisely known.

III

Issue: Should further introduction of exotic plant species to the Tahoe Region be banned?

Problems: 1. Introduction of some exotics is known to have imported new hosts for certain destructive plant diseases and insects.

2. Exotics may upset the ecological balance of native plants by competing for moisture and nutrients.

3. Exotics may prove to be additional hosts to endemic destructive organisms.

4. No controls on introduction of plant species now exist.

5. Introduced species may become weed pests.

IV

Issue: Should cleanup of slash after timber harvest be mandatory, or should slash be left in place?

Problems: 1. Dry slash is a potent fire hazard and is unattractive in appearance.

2. Slash provides some cover for wildlife and some soil building material.

3. Slash may become a breeding area for certain destructive insects and diseases.

4. Regulations for disposal of slash require enforcement and thereby incur costs.

5. Any mode of cleanup produces expense, but this may be offset by preventing damage from fire, insects, or disease.

6. Since various treatments of slash are possible, selection must be governed by local circumstances.

V

Issue: Should burning of slash continue to be permitted, or should it be banned in the interests of control of air quality?

Problems: 1. We have no precise information about effects of slash burning on air quality.

2. Burning must be timed to achieve maximum efficiency and safety simultaneously.

3. Burning produces sulfur dioxide and increases fallout of particulate matter.

VI

Issue: Should use of insect and disease controls on woodland be mandatory or voluntary?

Problems: 1. Mandatory controls require enforcement, which in turn incurs expense.

2. Adoption of either type of control, to be effective, requires public acceptance, which in turn requires a continuing program of public information.

3. There is no present means to motivate individuals to take necessary control action against insects and disease in timber.

4. To be effective, requirements for control would need to be uniform for publicly and privately owned land.

VII

Issue: Should further plant removal (timber harvest) be banned in order to maintain a dynamically balanced ecosystem?

Problems: 1. Present controls over logging and other removal of woody vegetation are inadequate.

2. Plant removal frequently required for urban development alters natural habitat of local fauna.

3. Such removal also alters the natural microclimate and the availability of soil moisture.

VIII

Issue: In setting up regulatory policy for land development, should priority be given to tolerance of plants to consequences of such development?

Problems: 1. We do not know exactly how much tolerance many species have for the changes wrought by urbanization.

2. We do not have full knowledge about how to develop with fewest unfavorable impacts on local plant life.

3. The public is apathetic toward use of available knowledge pertinent to development without adverse impacts.

4. The general public, and developers in particular, have not shown concern about the welfare of the plant community; in its view, a booming economy outweighs all values of plant life.

5. There is no program for developing public awareness of values and capabilities of plants.

IX

Issue: Should landscaping projects, whether private, commercial, or public, be restricted in any way?

Problems: 1. At present there are no controls on landscaping.

2. Neither is there any public acceptance of the theory of landscape controls.

3. The general public has very little knowledge about transplanting, need for or techniques of revegetation and regeneration, or of the possible adverse consequences of introducing exotic plants.

4. Implementing restrictions on landscaping would incur costs.

SUMMARY

The naturalness and attractiveness of the Lake Tahoe setting are generally acknowledged to result from the mosaic of varied native vegetation. Native plant species have the characteristics to reproduce, regenerate, and adapt to their surroundings after disturbance if the nutrient supplies in the soils are not lost.

Introduction of plant species (exotics) from outside the general Lake Tahoe region increases the risks of importing insects and diseases that are harmful to native vegetation. Some of these introduced plants may also serve as intermediate hosts for harmful organisms and may provide opportunity for endemic diseases to expand into an epidemic outbreak. Only those species from the outside that have been scientifically checked and cleared for use in the Tahoe Region should be permitted entry.

Plants play significant roles during much of their life span in deflecting or absorbing noise, filtering polluting gases, protecting soil, and maintaining water quality and quantity. Repeated interruption of cycles of plants' growth and of their various ecological integrals promotes erosion and loss of nutrients. Jurisdictional planning and zoning must be done carefully so as to minimize plant disturbance and to establish design criteria compatible with the wellbeing of native vegetation.

Careless urbanization practices have increased the severity of insect and disease problems in the Lake Tahoe region; notably, injuries to roots or trunks of trees have weakened them and made them very susceptible to attack by harmful insects and diseases; such attacks have caused further damage and sometimes death.

Trees have been weakened when levels of soil moisture were lowered; this made them susceptible to attack by insects and disease and resulted in further damage and sometimes death. Compaction of surface soil, paving large areas, constructing road fills, and use of certain chemicals near or immediately adjacent to some plants make them abnormally susceptible to damaging attack.

Plants are very sensitive to any impacts and environmental changes that affect life-supporting elements and growth processes. Plant ecologists and other plant scientists who can identify harmful disturbance and predict the consequences are available and should be consulted before any sizable disturbance is very definitely scheduled.

Since local nurseries do not grow or sell native plants or their seeds, there is virtually no opportunity to procure them for regeneration and revegetation of disturbed areas. Much of the topsoil in the region is so unstable and so lacking in plant nutrients that any attempt to establish vegetative cover is difficult.

Numerous native plants, if they were available, could be transplanted fairly easily when ground and growing conditions are right. However reestablishment of vegetation to enough density for it to become a functional part of the forest ecosystem is expensive and very slow. Design of buildings and landscape plans can provide the necessary protection for existing vegetation and can thereby simplify any program for revegetation.

Biological controls are preferable to chemical treatments for control of harmful plant insects and diseases. Compulsory requirements for all landowners to control troublesome insects and diseases are needed to prevent harmful epidemics of insects and diseases.

Disturbance and removal of vegetation must be regulated carefully if present standards of water quality are to be preserved and if natural beauty of the Tahoe environment is to be retained.

More research and information about the vegetation of the Lake Tahoe Region are needed before all the issues and problems relating to this vegetation can be solved.

GLOSSARY

Bog:	A poorly drained area rich in organic matter, usually acid in reaction; frequently surrounds open water and has characteristic flora (e.g., sedges, sphagnum).
Climax:	A species or type developed under a regional climate or unusual soil type that can regenerate without repeating a successional vegetation sequence.
Degree day:	A sum of 24 hours of temperatures above a specified minimum (usually 40° F for plant growth) daily temperature.
Evapotranspiration:	Loss of moisture from the soil both by evaporation from the surface and by transpiration through plants growing on it.
Fen:	A non-acid wet site typically with a water table at or near ground surface.
Flora:	The sum of all plant species growing in a given area.
Forb:	Any broadleaved herb.
Growing period:	The number of degree days necessary for a plant to complete its annual growth.
Growing season:	The span of time when sunlight, temperature, and moisture combine to allow the flora in a community to complete its annual growth (usually includes time for seed to mature).
Herb:	A non-woody vascular plant (some longer-lived perennials have a tough wood-like base).
Landscape:	An area the eye can see in a single view comprising a variety of biotic communities together with its topography, soils, and waterways.
Meadow:	A largely herbaceous plant community comprised chiefly of grasses and low-statured herbs often frequented by grazing animals.
Percolation:	Downward movement of water through the soil profile.
Riparian:	Pertaining to banks of streams that have running water all year.
Sedge:	A grasslike plant belonging to the genus **Carex,** usually with stems and leaves triangular in cross-section.
Soil:	A surface deposit consisting of sand, clay, and loam particles less than 2 mm in diameter; usually derived from rock fragments from bedrock or alluviums and from dead and decayed plant residues. Its development is influenced by the action of vegetation and climate.
Soil saturation:	A state of soil when nearly all interstices and pores are filled with water just before runoff occurs.
Succession:	Progression of the natural process of revegetation of a barren site; usually a sequence from lichens and mosses to weedy herbs (forbs), to grasses, to shrubs, to trees. May also describe the regeneration of plant communities through bog, fen, lowland, and forest climax.
Thicket:	A dense tangled stand of trees or shrubs (sometimes vines).

Transpiration: A process in which the sun's heat evaporates water from near leaf surfaces and water vapor from within the leaf diffuses out to fill the void. This transfer of water is principally through stomata—small pores in the stem and leaf surfaces that are controlled physiologically by the heat and moisture supply conditions within the plant. The supply of internal water is principally from the roots through the water-conducting tissues to the leaf.

Vegetation: All plants growing on a given site; types are usually named for species present in the greatest numbers or those species whose stature is largest (dominant).

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APPENDIX

Vegetation community types[2] and species composition in the Lake Tahoe Region

Type O: Open water. Includes standing or flowing water in lakes, creeks, rivers, and lagoons.

Common names	Scientific names
Open water	
Bolander quillwort	*Isoetes bolanderi*
Common cattail	*Typha latifolia*
Quillwort	*Isoetes muricata var. hesperia*
Pondweed, Richardson	*Potamogeton richardsonii*
Sedges	*Carex spp.*
Waterweed	*Elodea canadensis*
Swamps and pools	
Beaked sedge	*Carex rostrata*
Blister sedge	*C. vesicaria*
Indian pond lily	*Nymphaea polysepala*
Manna grass, northern	*Glyceria borealis*
Manna grass, tall	*G. elata*
Marsh marigold	*Caltha howellii*
Narrowleaf bur-reed	*Sparganium angustifolium*
Quillwort	*Isoetes braunii*
Vernal pools	
Lowland cudweed	*Gnaphalium palustre*
Meadow barley	*Hordeum brachyantherium*
Pull-up muhly	*Muhlenbergia filiformis*

Type 1: Bare ground (natural), Alpine. Areas practically devoid of vegetation because of a limitation imposed by a natural, physical, or climatic factor. Most of these areas are near the summit of ridges or mountain tops; often rocky high elevation or snow flush areas.

Bedstraw	*Galium grayanum*
Douglas chaenactis	*Chaenactis douglasii*
Elephanthead lousewort	*Pedicularis groenlandica*
Barestem eriogonum	*Eriogonum nudem*
Graphite eriogonum	*E. lobbii*
Fleabane	*Erigeron barbellalatus*
Gayophytum	*Gayophytum nuttallii*
Gilia	*Gilia leptalea*
Stemless goldenweed	*Haplopappus acaulis*
Goosefoot violet	*Viola purpurea*
Knotweed	*Polygonum davisiae*
Mint	*Monardella odoratissima*
Phacelia	*Phacelia mutabilis*

2 Nearly 30 general plant community types were identified in a study of plant life in California; 13 of these are in the Lake Tahoe Region. The type numbering in this list corresponds to numbering in the California inventory; so it is not fully consecutive here.

Common names	Scientific names
Heretic penstemon	*Penstemon heterodoxus*
Rush	*Juncus mertensiana*
Rush	*J. nevadensis*
Saxifrage	*Saxifraga bryophora*
Sibbaldia	*Sibbaldia procumbens*
Sierra primrose	*Primula suffrutescens*
Sticky currant	*Ribes viscosissimum*
Windflower	*Anemone drummondii*

Type 1a: Bare ground (disturbed). Areas of sparse vegetation because of man-caused or related factors, usually in lowland areas; most species are introduced weeds.

Vernal pools

Coyote tobacco	*Nicotiana attenuata*
Fleabane	*Conyza canadensis*
Flixweed	*Descurainia sophia*
Lamb's quarters	*Chenopodium alba*
Lupine	*Lupinus lepidus var. farreyi*
Russian thistle	*Salsola kali*
Squirreltail (or bottlebrush)	*Sitanion hystrix*
Willow herb	*Epilobium glaberrimum*
Wiregrass (or yardgrass)	*Polygonum aviculare*

Type 2: Herbaceous. Vegetation is made up of many combinations of species of low growing, non-woody herbs and grasses (may include a thin scattering of trees or shrubs) in meadows, marshes, or grass areas.

Wet marsh or meadow

Aster	*Aster alpegius*
Awl bulrush	*Scirpus congdonii*
Hairgrass, slender	*Aira elongata*
Hairgrass, tufted	*A. caespitosa*
Monkeyflower, meadow	*Mimulus primuloides*
Monkeyflower, common	*M. guttatus*
Oatgrass, American	*Danthonia americana*
Rush	*Juncus mertensianus*
Sedge, abruptbeak	*Carex abrupta*
Sedge, awl	*C. nervina*
Sedge, sheep	*C. illota*
Sedge	*C. heteroneura*
Sedge	*C. leporinella*
Shootingstar, Sierra	*Dodecatheon jeffreyi*
Woodrush, Donner	*Luzula subcongesta*
Woodrush	*L. intermedia*

Mesic herb

Pale agoseris	*Agoseris glauca*
Balsamroot	*Balsamorhiza sagittata*
Alpine brodiaea	*Brodiaea lutea var. ixiodes*
Buckwheat	*Eriogonum latifolium var. nudum*
Bulbrooted melic	*Melica bulbosa*
California bromegrass	*Bromus carinatus*
Chaenactis	*Chaenactis douglasii*
Checkerbloom	*Sidalcea glaucescens*

Common names	Scientific names
Cinquefoil, gland	*Potentilla glandulosa*
Cymopterus	*Pterixia terebinthina*
Star gilia	*Ipomopsis aggregata*
Groundsmoke	*Gayophytum nuttallii*
Helianthella, California	*Helianthella californica*
Mariposa lily	*Chalochortus leichthinii*
Mint pennyroyal	*Monardella odoratissima*
Mule ears	*Wyethia mollis*
Needlegrass	*Stipa californica*
Wild ryegrass	*Elymus canadensis*
Squirreltail grass	*Sitanion hystrix*
Stickseed	*Hackelia longituba*

Sphagnum bog

Bentgrass, Thurber	*Agrostis thurberiana*
Bog orchid	*Habenaria dilatata*
Cinquefoil, marsh	*Potentilla palustris*
Laurel, pale	*Kalmia polifolia*
Manna grass, tall	*Glyceria elata*
Pondweed	*Potamogeton gramineus*
Rush	*Juncus longistylus*
Sedge	*Dulichium arundinaceum*
Sedge	*Carex kelloggii*
Sedge	*C. ormantha*
Sedge	*C. vesicaria*
Sundew, roundleaf	*Drosera rotundifolia*
Twinberry	*Lonicera cauriana*
Valerian, western	*Valeriana occidentalis*
Willow, Lemmon's	*Salix lemmonii*

Wet mesic meadow

Agoseris, pale	*Agoseris glauca*
Aster	*Aster alpigenus*
Aster, thick stem	*A. integrefolius*
Bentgrass	*Agrostis ampla*
Bluegrass, Kentucky	*Poa pratensis*
Brodiaea, white	*Brodiaea hyacintha*
Checkerbloom	*Sidalcea oregana*
Clover, alpine	*Trifolium longipes*
Fleabane	*Erigeron peregrinus*
Fleabane, meadow	*E. coulteri*
Hairgrass, tufted	*Aira caespitosa*
Grays lovage	*Ligusticum grayi*
Meadow barley	*Hordeum brachyantherium*
Parishia yampha	*Perideridia parishii*
Polemonium, western	*Polemonium occidentalis*
Corn lily	*Veratrum californicum*
Reedgrass	*Calamagrostis spp.*
Sedge	*Carex spp.*
Timothy, alpine	*Phleum alpinum*

Type 4: Sagebrush.

Shrubs are dominant plants—typically sagebrush, bitterbrush, rabbitbrush, mule ears, and, on the east side of the Basin, mountain mahogany. Bunch grasses may be scattered sparsely. Soils are poor, unstable (usually sandy), and very well drained. Top soils dry out rapidly in summer.

Common names	Scientific names
Big sagebrush	*Artemisia tridentata*
Bitterbrush	*Purshia tridentata*
Buckwheat, marum-leaved	*Eriogonum mariflorum*
Buckwheat, sulfur-flowered	*E. umbellatum*
Buckwheat, Wright's	*E. wrightii*
Curlleaf mountain mahogany	*Cercocarpus ledifolius*
Dwarf sagebrush	*Artemisia arbuscula*
Sierra monkey flower	*Mimulus coccineus*
Mule ears	*Wyethia mollis*
Needlegrass	*Stipa lemmoni*
Rabbitbrush	*Chrysothamnus nauseosus*
Squirreltail grass	*Sitanion hystrix*

Type 6: Montane chaparral.

Associations of the "hard" woody shrubs almost of impenetrable density. The type is excellent cover for watersheds but also a very high fire hazard.

Arrowleaf balsamroot	*Balsamorhiza sagittata*
Bitterbrush	*Purshia tridentata*
Bitter cherry	*Prunus emarginata*
Brewer's monkey flower	*Mimulus breweri*
Bush chinquapin	*Castinopsis sempervirens*
Checkerbloom	*Sidalcea glaucescens*
Douglas chaenactis	*Chaenactis douglasi*
Green manzanita	*Arctostaphylos patula*
Huckleberry oak	*Quercus vaccinifolia*
Large-flowered stephanomeria	*Stephanomeria lactucina*
Mountain whitethorn	*Ceanothus cordulatus*
Mule ears	*Wyethia mollis*
Rabbitbrush	*Chrysothamnus spp.*
Squirreltail grass	*Sitanion hystrix*
Waxberry	*Symphoricarpos acutus*

Type 7: Riparian shrub.

Association of shrubby species with an understory of herbs along streams, lakes, lagoons, marshes, and meadows. Sites are mostly seepage areas but occasionally are associated and merging with the wet broadleaf type.

Willow thicket

Bedstraw	*Galium bifolium*
Columbine	*Aquilegia formosa*
Creek dogwood	*Cornus californica*
Groundsel	*Senecio triangularis*
Lupine, Washington	*Lupinus polyphylus*
Mountain alder	*Alnus tenuifolia*
Ranger's buttons	*Sphenosciadium capitellatum*
Willow, Pacific	*Salix lasiandra*
Willow, Scouler's	*S. scouleriana*
Willow herb	*Epilobium hornmanei*

Alder thicket

Alumroot	*Heuchera micrantha*

Common names	Scientific names
Arnica	*Arnica amplexicaulis*
Brewer's mitterwort	*Mitella breweri*
Elderberry	*Sambucus racemosa spp.*
Indian paintbrush	*Castilleja miniata*
Lady fern	*Athyrium alpestre*
Larkspur	*Delphinium glauca*
Lupine, Washington	*Lupinus polyphylus*
Monkey flower, common	*Mimulus guttatus*
Monkey flower, pink	*M. lewisii*
Willow, Jepson's	*Salix jepsonii*
Willow, Lemmon's	*S. lemmonii*

WOODLAND TREE TYPES

Type 9: Broadleaf.

Areas on which the dominant vegetation is broadleaf trees generally growing in closed canopy stands. Their occurrence generally indicates moist deep soils.

Low elevations

Aspen	*Populus tremuloides*
Black cottonwood	*P. trichocarpa*
Cowparsnip	*Heracleum lanatum*
Creek dogwood	*Cornus californica*
Dogwood	*C. sessilis*
Giant hyssop	*Agastache urticifolia*
Groundsel	*Senecio triangularis*
Honeysuckle, twin-flower	*Lonicera conjugialis*
Mountain alder	*Alnus tenuifolia*
Ranger's buttons	*Sphenosciadium capitellatum*
Thimbleberry	*Rubus parviflorus*
Willow, Pacific	*Salix lasiandra*
Willow, Scouler's	*S. scouleriana*

High elevations

Alumroot	*Heuchera micrantha*
Arnica	*Arnica amplexicaulis*
Brewer's mitterwort	*Mitella breweri*
Elderberry	*Sambucus racemosa spp.*
Indian paintbrush	*Castilleja miniata*
Lady fern	*Athyrium alpestre var. americanum*
Larkspur	*Delphinium glauca*
Lupine, Washington	*Lupinus polyphylus*
Monkey flower, common	*Mimulus guttatus*
Monkey flower, pink	*M. lewisii*
Willow, Jepson's	*Salix jepsonii*
Willow, Lemmon's	*S. lemmonii*

CONIFER TYPES

Type 14: Pine.

Open, nearly pure pine stands where pines form approximately 80 percent or more of the vegetation cover. This type is most common on east, south, and southwest exposures.

Balsamroot	*Balsamorhiza sagittata*
White fir	*Abies concolor*

Common names	Scientific names
Hedgenettle	*Agastache urticifolia*
Mule ears	*Wyethia mollis*
Pennyroyal	*Monardella odoratissima*
Penstemon	*Penstemon deustus*
Phacelia	*Phacelia mutabilis*
Jeffrey pine	*Pinus jeffreyi*
Lodgepole pine	*P. contorta var. murryana*
Ponderosa pine	*P. ponderosa*
Big sagebrush	*Artemisia tridentata*
Mountain whitethorn	*Ceanothus cordulatus*

Type 17: Mixed conifer.

Various combinations of evergreen conifers, sparse grasses, herbs, and low shrubs. Most of the commercial conifer species found in the Lake Tahoe Region are in this type.

Brewer's golden aster	*Chrysopsis breweri*
Balsamroot	*Balsamorhiza sagittata*
Bitterbrush	*Purshia tridentata*
Bitter cherry	*Prunus emarginata*
Bush chinquapin	*Castinopsis sempervirens*
Cedar, incense	*Libocedrus decurrens*
Douglas' chaenactis	*Chaenactis douglasii*
Red fir	*Abies magnifica*
White fir	*A. concolor*
Hedgenettle	*Agastache urticifolia*
Huckleberry oak	*Quercus vaccinifolia*
Green manzanita	*Arctostaphylos patula*
Brewer's monkey flower	*Mimulus breweri*
Mule ears	*Wyethia mollis*
Pennyroyal	*Monardella odoratissima*
Phacelia	*Phacelia mutabilis*
Penstemon	*Penstemon deustus*
Pine, Jeffrey	*Pinus jeffreyi*
Pine, lodgepole	*P. contorta var. murryana*
Pine, ponderosa	*P. ponderosa*
Pine, sugar	*P. lambertiana*
Squirreltail grass	*Sitanion hystrix*
Stephanomeria, large flowered	*Stephanomeria lactucina*
Tobacco snowbrush	*Ceanothus velutinus*
Waxberry	*Symphoricarpos acutus*
Mountain whitethorn	*Ceanothus cordulatus*

Type 18: Fir.

Areas where true firs are the dominant trees This type is most common on north and east exposures.

High elevations

Currant, sticky	*Ribes viscosissimum*
Fir, red	*Abies magnifica*
Brewer's golden aster	*Chrysopsis breweri*
White hawkweed	*Hieracium albiflorum*
Mountain hemlock	*Tsuga mertensiana*
Kelloggia	*Kelloggia galloides*
Lousewort	*Pedicularis semibarbata*
Lupine, Anderson's	*Lupinus andersoni*
Pine, Jeffrey	*Pinus jeffreyi*
Pine, western white	*P. monticola*

Low elevation

Red fir	*Abies magnifica*

Common names	Scientific names
White fir	*A. concolor*
Sierra gooseberry	*Ribes roezlii*
Jeffrey pine	*Pinus jeffreyi*
Woodland pine drops	*Pterospora andromedea*
Princenut	*Chimaphila umbellata*
Sweet cicely	*Osmorrhiza chilensis*
Waxberry	*Symphoricarpos acutus*

Type 19: Lodgepole.

Areas where lodgepole pine is completely dominant, but in older well-drained stands white fir may occur. Most sites are wet mesic and are often adjacent to herbaceous meadows. Lodgepole stands are also pioneer trees on dry rocky sites in red fir elevations, and the associated plants are similar to the red fir types.

Wet type

Arnica	*Arnica diversifolia*
Arrowleaf groundsel	*Senecio triangularis*
Meadow barley	*Hordeum nodosum*
Bent grass	*Agrostis ampla*
Corn lily	*Veratrum californicum*
Common horsetail	*Equisetum arvense*
Lodgepole pine	*Pinus contorta murrayana*
Mountain alder	*Alnus tenuifolia*
Musk monkey flower	*Mimulus moschatus*
Ranger's buttons	*Sphenosciadium capitellatum*
Reedgrass	*Calamagrostis spp.*
Scouler's willow	*Salix scouleriana*
Tufted hair grass	*Aira caespitosa*
Western wildrye	*Elymus canadensis*

Mesic type

Western aster	*Aster occidentalis*
Bolander's bluegrass	*Poa bolanderi*
Cinquefoil	*Potentilla glandulosa*
Gray's lovage	*Ligusticum grayi*
Mountain clover	*Trifolium cyathiferum*
Mountain violet	*Viola purpurea*
Nebraska sedge	*Carex nebraskensis*
Ross sedge	*Carex rossii*
Waterleaf phacelia	*Phacelia hydrophylloides*
Rock cress	*Arabis holbellii*
Spike trisetum	*Trisetum spicatum*

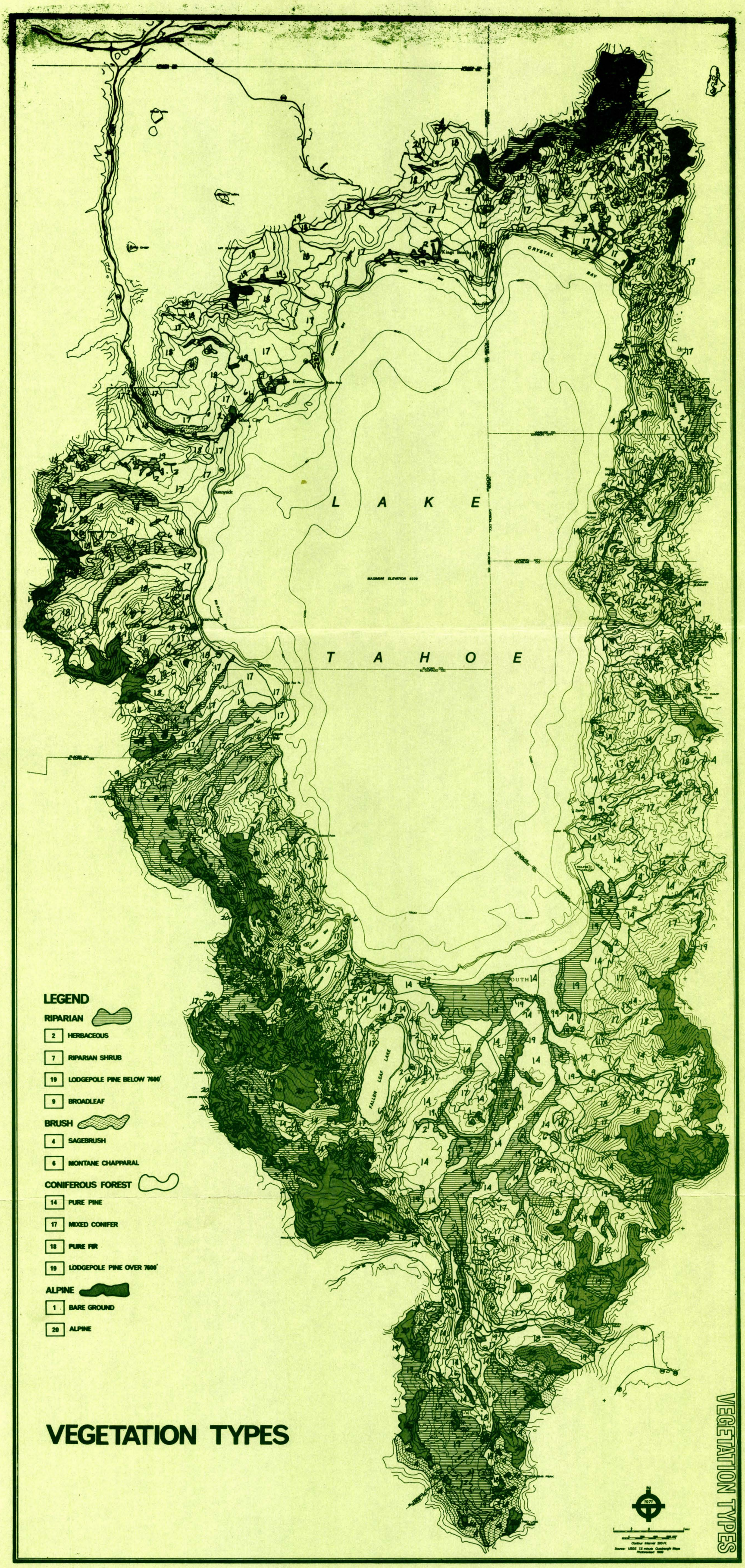
ALPINE TYPES

Type 20: Alpine.

Grasses, forbs, shrubs and trees found at high elevations where temperatures are extreme and soils are poor.

Sierra chaenactis	*Chaenactis nevadensis*
Elephant heads	*Pedicularis groenlandica*
Fleabane	*Erigeron barbellatus*
Gilia	*Gilia leptalea*
Mountain hemlock	*Tsuga mertensiana*
Western juniper	*Juniperus occidentalis*

Common names	Scientific names
Davis' knotweed	*Polygonum davisiae*
Wild onion	*Allium platycaule*
Sugar pine	*Pinus lambertiana*
Western white pine	*P. monticola*
Whitebark pine	*P. albicaulis*
Sierra primrose	*Primula suffrutescens*
Rush	*Juncus mertensiana*
Saxifrage	*Saxifraga bryophora*
Sibbaldia	*Sibbaldia procumbens*
Drummond's windflower	*Anemone drummondi*



VEGETATION TYPES

VEGETATION TYPES

LAKE TAHOE REGION

TAHOE REGIONAL PLANNING AGENCY

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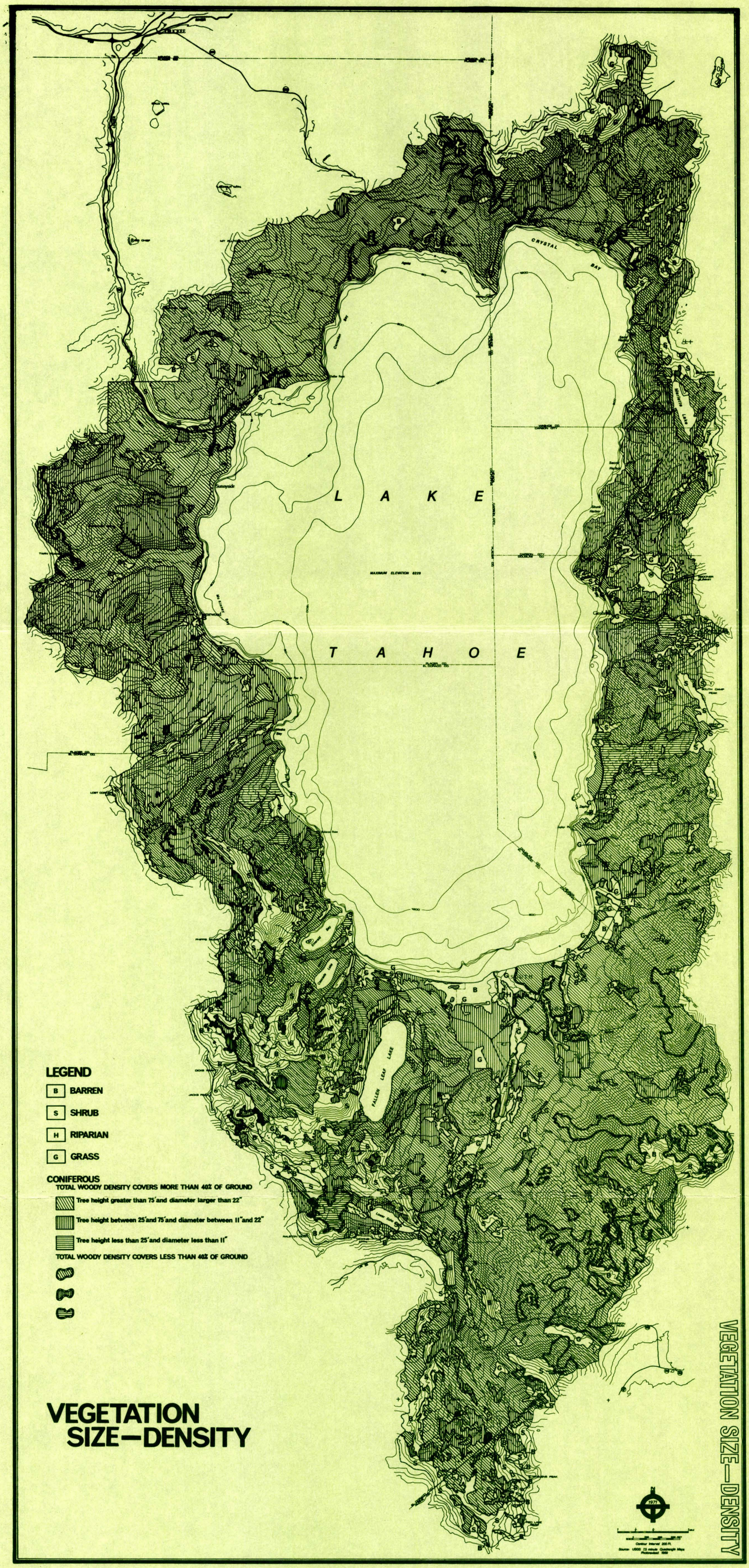

LEGEND

- B BARREN
- S SHRUB
- H RIPARIAN
- G GRASS

CONIFEROUS

TOTAL WOODY DENSITY COVERS MORE THAN 40% OF GROUND

- Tree height greater than 75' and diameter larger than 22"
- Tree height between 25' and 75' and diameter between 11" and 22"
- Tree height less than 25' and diameter less than 11"

TOTAL WOODY DENSITY COVERS LESS THAN 40% OF GROUND

VEGETATION SIZE—DENSITY

VEGETATION SIZE—DENSITY

LAKE TAHOE REGION

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This publication is one of a group issued jointly by the Tahoe Regional Planning Agency and the USDA Forest Service. Each publication describes and inventories a natural resource or other characteristic that is significant to the total environment of the Lake Tahoe Region; it attempts to show the hazards incidental to improperly planned development of the area and to provide information helpful in designing controls that must be implemented if the scenic beauty of the Lake Tahoe Region is to be preserved and its other natural resources are to be conserved. These publications are not exhaustive treatises of their subjects, but they highlight the known significant information and data useful in the planning effort underway. Subjects of publications in this series are:

Climate and Air Quality of the Lake Tahoe Region

Cultural and Historical Significance of the Lake Tahoe Region

Land Resources of the Lake Tahoe Region

Fisheries of Lake Tahoe and Its Tributary Waters

Geology and Geomorphology of the Lake Tahoe Region

Hydrology and Water Resources of the Lake Tahoe Region

Limnology and Water Quality of Lake Tahoe and Tributary Waters

Recreational Resources of the Lake Tahoe Region

Wildlife of the Lake Tahoe Region

Soils of the Lake Tahoe Region

Vegetation of the Lake Tahoe Region

Scenic Analyses of the Lake Tahoe Region

Because of the heavy expense of publication and because these reports are designed chiefly for use by planners, supplies are not available for general public distribution.